2 FISH POPULATIONS OF THE LAKE OZETTE WATERSHED

As described above, there are thought to be at least 25 species of fish within the Lake Ozette watershed, making it one of the most species-rich lakes in Washington State. This chapter presents a brief review of the fish species present within the watershed and the locations of available information relating to the distribution, abundance, current and past harvest (where applicable), and trends in abundance for as many species for which data exist. In addition, for species that are potential competitors with, or predators of, sockeye salmon, general information on habitat utilization, diet, and relationship to sockeye salmon is included. Note that sockeye salmon biology is summarized in Chapter 3.

2.1 SALMONID POPULATIONS

Salmonid populations in the Lake Ozette watershed (in addition to sockeye salmon) are kokanee (non-anadromous) salmon, coho salmon, chum salmon, Chinook salmon, steelhead, and coastal cutthroat trout.

2.1.1 Kokanee Salmon (Oncorhynchus nerka kennerlyi)

Kokanee salmon in Lake Ozette are classified as an independent population of resident (non-anadromous) sockeye (Gustafson et al. 1997). No official stock designation has been given to the kokanee population(s) in the Ozette watershed, but they are considered native and are sustained through natural production. Lake Ozette kokanee are ***NOT*** part of the Lake Ozette sockeye salmon ESU. The West Coast Sockeye Biological Review Team (BRT) concluded that, "*Based on the very large genetic distance between Ozette Lake kokanee that spawn in tributaries and Ozette Lake sockeye salmon that spawn on shoreline beaches, the BRT excluded Ozette Lake kokanee from this sockeye salmon ESU.*"

2.1.1.1 Current and Historical Abundance

No historical (pre-1975) data exist for kokanee salmon spawning aggregations in the Ozette system. Population estimates for kokanee are poorly documented. Beauchamp et al. (1995) concluded that from 1980 through 1992, tributary spawning kokanee numbered between 5,000 and 10,000 spawners per year. However, the methods used to make this estimate are not described. From a review of spawning ground data and other documented descriptions of survey efforts during this time period, it was impossible to accurately estimate the annual total number of spawning kokanee. Spawning ground surveys in the fall of 1987 detected several thousand kokanee spawning or holding in lower Siwash Creek (MFM 1987). Recent survey efforts have not been designed to

quantify the total abundance of spawning kokanee, and therefore no estimates of recent population abundance are available.

2.1.1.2 Kokanee Salmon Life History

2.1.1.2.1 Adult and Sub-Adult Kokanee Rearing in Lake Ozette

Anadromous sockeye and kokanee early life histories and freshwater rearing in the lake overlap. During their rearing phase, kokanee mix extensively in the lake with juvenile sockeye salmon (Jacobs et al. 1996). No attempt to differentiate the two populations during the lake rearing phase of their life-history has been attempted. Beauchamp and LaRiviere (1993) collected data on the age of *O. nerka* individuals captured in vertical gillnets. No age 4 sockeye/kokanee were captured during their study. This indicates that all kokanee spawn by the age 4. It was assumed that the majority of kokanee rear in lake for four springs and summers, and then spawn during their fourth fall. Jacobs et al. (1996) concluded that there are several lines of evidence indicating that sockeye salmon abundance is not suppressed by competition for food by kokanee.

2.1.1.2.2 Adult Kokanee Migration and Spawning

Little is known with respect to kokanee pre-spawning holding and migration patterns. Large numbers (~50) of kokanee-sized *O. nerka* have been observed holding adjacent to Allen's Beach during the sockeye spawning season. A similar behavior has been observed with large numbers of coho salmon (~100) at Olsen's Beach. In fact, even chum salmon have been observed holding and potentially spawning on the beaches. Kokanee spawning primarily occurs in tributaries, but to a much lesser degree kokanee-sized *O. nerka* also spawn on both Allen's and Olsen's beaches (MFM unpublished spawning ground surveys; Dlugokenski et al. 1981; Crewson et al. 2001; Hawkins 2004). Kokanee spawning ground survey data and genetic tissue sampling data indicate that kokanee spawn in all low-gradient streams with suitable substrate entering the lake, with the exception of the mainstem Big River. Kokanee spawning typically occurs from early November until mid-December (MFM, unpublished spawning ground survey data). Spawning kokanee are quite small. During genetic tissue sampling in 2000 and 2001, a total of 444 individuals were sampled for length (streams sampled: Crooked, Siwash, Elk, Rayonier Landing, and Cedar creeks, as well as an unnamed tributary to Crooked Creek and unnamed tributary 20.0073). Females averaged 22.4 cm fork length (FL) and males averaged 23.3 cm FL (Table 2.1). Fecundity data collected in 1990 found 402 eggs/female (n=81; MFM unpublished broodstock data).

Table 2.1. Summary of spawning kokanee length data collected during genetic tissue sampling in several Lake Ozette tributaries (source: MFM, unpublished genetic tissue database).

Sex	n	Maximum Length (cm FL)	Minimum Length (cm FL)	Average (cm FL)
Females	178	25.5	18.0	22.4
Males	235	27.0	19.0	23.3
Unknown	31	26.0	21.0	23.6
Total	444	27.0	18.0	22.9

With the exception of Crooked Creek, kokanee appear to prefer smaller tributaries for spawning. A thorough review of over 1,500 spawning ground surveys conducted between 1970 and 2004 indicates that Umbrella Creek and Big River do not have kokanee spawning aggregations as seen in the primary spawning grounds. A review of over 300 spawning ground surveys only revealed one observation of two kokanee size *O. nerka* in Big River. Kokanee have been observed spawning in Solberg Creek and Boe Creek, tributaries to Big River. Kokanee-sized *O. nerka* in Umbrella Creek are observed in low numbers on most years. Between 1970 and 2004 the peak Umbrella Creek kokanee count was 49 fish per mile in 1987, however, this survey appears to be an anomaly. During the same period over 300 surveys have been conducted and the next highest peak count was less than 6 fish per mile, during several years no kokanee or kokanee sized *O. nerka* have been observed in Umbrella Creek. Figure 2.1 depicts the annual peak kokanee counts per mile for all streams with multiple years of kokanee spawning ground surveys.

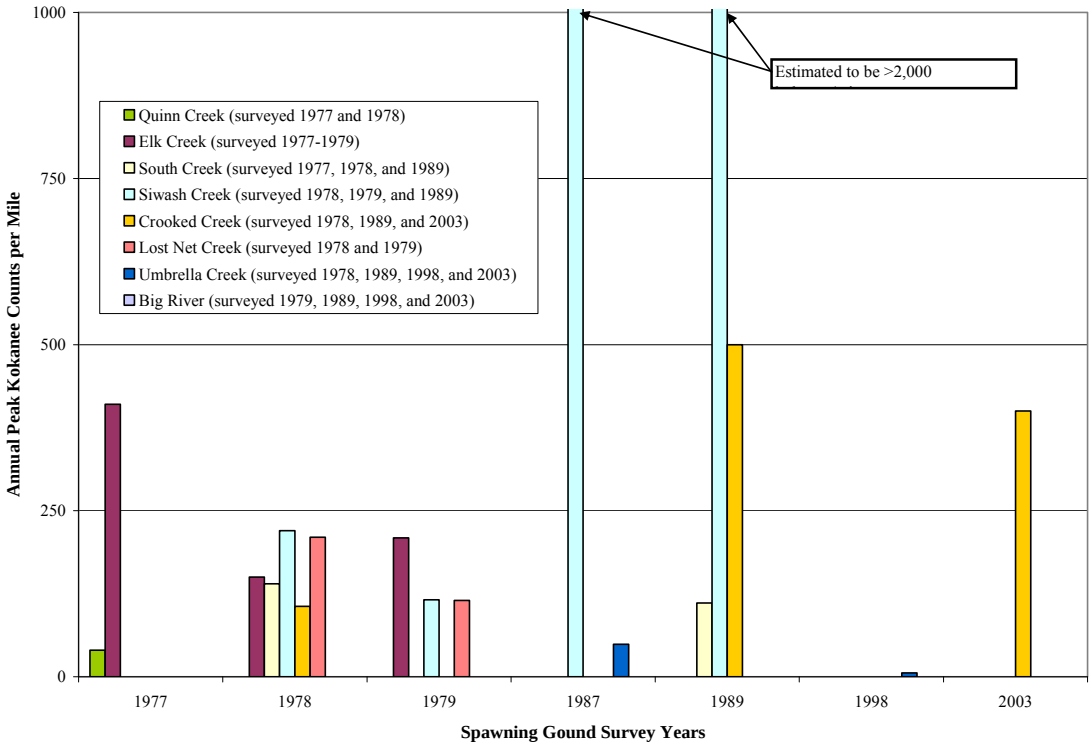

Figure 2.1. Annual peak kokanee counts per mile for select streams during spawning years 1977, 1978, 1979, 1989, 1998, and 2003 (source: Dlugokenski et al. 1981; MFM spawning ground survey database).

2.1.1.2.3 Kokanee Fry Emergence, Dispersal, and Early-Rearing

No direct data has been collected regarding kokanee fry emergence, dispersal, and early-rearing. It is assumed that since spawn timing is similar to that of tributary spawning sockeye that emergence timing is also similar. See Section 3.1.8.

2.1.1.3 Hatchery Practices and Planting History

Currently there are no hatchery releases of kokanee or kokanee- sockeye hybrids in the Ozette system. Past stocking efforts have been relatively limited. In 1940 over 108,000 kokanee fry from the Lake Crescent Trout Hatchery were released into Lake Ozette (Kloempken 1996 *in* Gustafson et al. 1997). Dlugokenski et al. (1981) also reports a kokanee release of an unknown quantity and origin into Lake Ozette in 1958. The most recent kokanee releases in the Ozette watershed occurred with brood year 1990 and 1991 sockeye x Siwash Creek kokanee hybrids. A total of 2,915 and 11,483 sockeye x kokanee hybrids were released into Lake Ozette July 1991 and 1992 respectively. In 1990, 81 Siwash Creek female sockeye were spawned with five male sockeye captured at Olsen's Beach (MFM, unpublished hatchery records) . In 1992, 94 Siwash Creek

females were spawned with 12 male sockeye from either Allen's or Olsen's Beach or a mix from both beaches (MFM, unpublished hatchery records).

2.1.1.4 Kokanee Salmon Genetics

The genetics of Lake Ozette sockeye and kokanee are examined in detail in Gustafson et al. (1997), Crewson et al. (2001), and Hawkins (2004). Gustafson et al. (1997) concluded that Lake Ozette kokanee were genetically dissimilar from Lake Ozette sockeye, as well as all other anadromous sockeye populations examined in Washington State. Lake Ozette kokanee proved to be the most genetically distinct *O. nerka* population examined in a genetic comparison between different kokanee/sockeye salmon populations from the contiguous United States (Gustafson et al. 1997). Lake Ozette kokanee clustered most closely with Vancouver Island sockeye populations. Hawkins (2004) compared Lake Ozette kokanee genetic samples to test whether the Ozette kokanee stock contained multiple populations. Hawkins (2004) concluded that the Lake Ozette kokanee populations probably comprise one panmictic group. There were no genetic differences among the collections analyzed by Hawkins (2004).

2.1.2 Coho Salmon (*Oncorhynchus kisutch*)

Coho salmon are native to the Ozette watershed and are sustained through wild production (WDF et al. 1994; WDFW 2002). Coho salmon in the Ozette watershed have been identified as a distinct stock in recent stock assessments (Nehlsen et al. 1991; WDF et al. 1994; McHenry et al. 1996; WDFW 2002).

2.1.2.1 Current and Historical Abundance

Historically coho salmon were particularly abundant in Lake Ozette, potentially the most abundant anadromous salmonid in the watershed. Kemmerich (1945) reported counting 9,611 coho salmon passing the weir in the Ozette River between September 24 and October 16, 1924. In the same year, Kemmerich (1945) reported counts of 3,241[5] sockeye transiting the weir between May 27 and August 8. In 1925, a partial check of the coho salmon run was conducted by Kemmerich (1945) and in excess of 10,000 coho salmon were counted through the weir in a two-day period. In this same year, 6,343 sockeye were counted transiting the weir between June 8 and September 15 (it is unclear whether this is a complete count of the sockeye run or not). No data on coho abundance could be found for the years between 1926 and 1947. Starting in 1948, there are coho salmon harvest data for the Ozette River. Figure 2.2 depicts coho harvest data and weir data from the Ozette. Harvest of Lake Ozette coho between 1948 and 1957 averaged approximately 1,600 fish per year. Harvest declined precipitously during the next 10 years, averaging only 300 to 400 coho per year. Harvest from 1968 to 1972 averaged less than 300 coho per year. Lestelle (1996) suggests that the decline of Lake Ozette coho is

[5] The weir was undermined during the sockeye enumeration period and several days passed prior to repairing the weir, so the 3,241 sockeye counted were only a partial count of the run.

an indicator of how coho salmon habitat was changing in the watershed during this time period. Dlugokenski et al. (1981) suggest that the decline in harvest may have been a result of decreased effort after most of the individuals living at Ozette moved to Neah Bay in the 1950s. Nonetheless, it seems reasonable that Lake Ozette coho run sizes were much greater than 10,000 fish per year in the 1920s (after the in-river fisheries had harvested an unknown number of fish) and that harvest declined sharply in the late 1950s and 1960s to a point that a terminal fishery could no longer be supported.

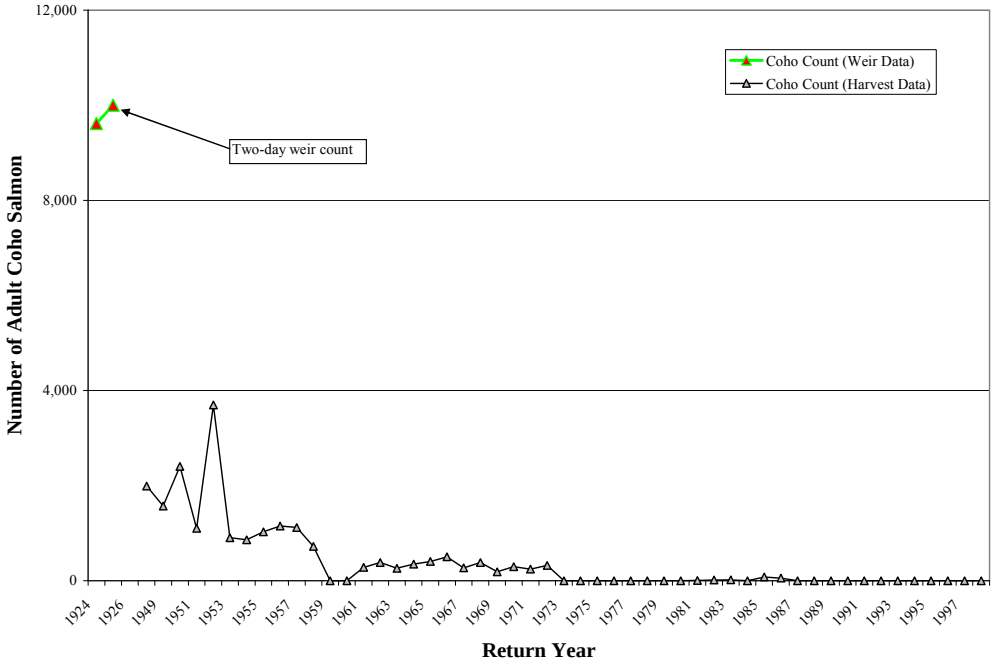

Figure 2.2. Coho salmon weir counts and harvest trends for available data from 1924 through 1999 (source: Kemmerich 1945; Jacobs et al. 1996, MFM 2000).

Currently there are no spawning escapement estimates for Lake Ozette coho; therefore no trend analysis could be conducted for this stock. Long-term spawning ground survey data are available for only two streams. The dataset contains 19 years of surveys which took place from return year 1974 to 2004. WDFW conducted spawning ground surveys in an index reach of Big River[6] (from the 7402 Rd Bridge to Boe Creek) from 1974 through 1985 (excluding 1984) and in the lower 0.6 miles of Boe Creek (from 1974 through 1986, excluding 1984). The Makah Tribe began conducting coho spawning ground surveys in 1998 in these same stream reaches. However, the Tribe's index reach in Big River extends downstream from the 7402 Bridge past Boe Creek, to the Hoko-Ozette Road Bridge and in Boe Creek the survey is 1.0 miles in length versus of the 0.6 miles surveyed in the WDFW index reach. Figure 2.3 depicts the annual number of surveys conducted within each of the spawning ground survey reaches, as well as the annual peak coho counts per mile. While the overall quantity and quality of Lake Ozette

[6] WDFW surveys are recorded in their database as taking place between RM 9.4 and 8.3, however, these river miles are based on river miles depicted in Phinney and Bucknell (1975). These river miles correspond to RM 10.81 to RM 9.4 in Haggerty and Ritchie (2004). Stream lengths in Haggerty and Ritchie (2004) are the basis for all river miles described in this report, as well as river miles used in MFM spawning ground surveys from 1998-2004.

coho abundance data are quite limited some general inferences can be made regarding the number of coho salmon on the spawning grounds. Peak coho counts in Big River and Boe Creek from 1974 to 1986 averaged 15 and 26 coho per mile respectively and from 1998 through 2004 peak counts averaged 40 and 196 coho per mile; equating to a 2.5 and 7.5 fold increase respectively.

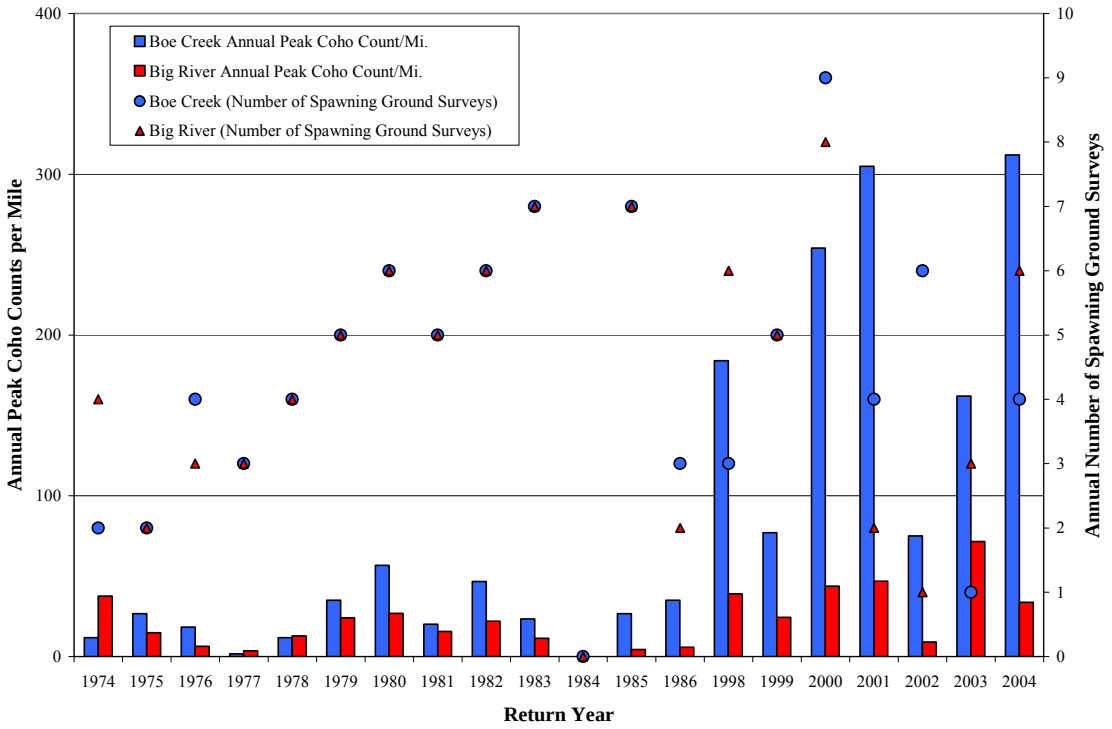

Figure 2.3. Summary of the annual number of spawning ground surveys conducted within index survey reaches and annual peak coho counts per mile in Big River and Boe Creek spawning ground index reaches from 1974 to 1986 and 1998 to 2004 (source: WDFW spawning ground survey database; MFM spawning ground survey database).

2.1.2.2 Coho Salmon Life History

2.1.2.2.1 Adult Coho Entering System

Very little data have been collected related to adult coho salmon migration and entry into Lake Ozette. Kemmerich (1926) describes entry timing into the lake starting in mid-September with peak counts corresponding to the first initial rise of the lake in early fall. In 1999 the sockeye counting weir was fished in the Ozette River until October 1, approximately 45 days later than in other years. On August 27, 1999 the first coho salmon was observed transiting the weir (MFM unpublished weir counts). Coho salmon continued to trickle into the lake averaging from 1 to 7 fish per day throughout the duration of the monitoring period. Rainfall during this period was low; only 2.04 inches (51.8 mm) of rainfall were measured between August 17 and October 1 (ONP unpublished rainfall data collected at the Ozette Ranger Station), and subsequently there

was no rise in lake or river levels. WDF (1955) reports that the greatest abundance of coho salmon in the Ozette River occurs during the months of September through November.

2.1.2.2.2 Adult Coho Holding in Lake Ozette

Little is known regarding adult coho holding in Lake Ozette. Adult coho salmon have been observed milling and jumping in Swan Bay in September and early October, as well as other areas of the lake. It is assumed that fish holding in the lake are waiting for streamflows to increase so they can ascend tributaries and reach the spawning grounds. In 2000, fall rains were later than normal, and streamflows and lake levels did not rise until late November. In the fall of 2000, a few hundred coho salmon were observed holding just offshore of Olsen's Beach, apparently waiting for rain so they could ascend nearby tributaries to spawn.

2.1.2.2.3 Adult Coho Migration and Spawning in Tributaries

Coho salmon distribution in the Ozette watershed is depicted in Figure 2.4. Coho salmon have been found to spawn in all accessible low-gradient streams where suitable spawning gravel exists. In general spawning coho salmon have a preference for small tributaries where bankfull width is typically less than 30-40 feet (9-12 meters). In larger streams such as Big River, Umbrella Creek, and Crooked Creek coho spawning is typically limited in the lower, wider sections. The number of spawners per mile increases towards the upper watersheds of these stream systems and in smaller side tributaries. The timing of coho salmon migration into Ozette tributaries remains relatively unstudied. Weir data collected at the Umbrella Creek weir from 2001 through 2004 suggests that coho salmon migrate upstream soon after the first significant rise in streamflow in October or early-November. Figure 2.5 illustrates the relationship between streamflow and coho entry into Umbrella Creek. The earliest coho entry during this period was on October 14, 2001 and the latest first entry occurred on November 8, 2002 after a prolonged period of unseasonably low flows.

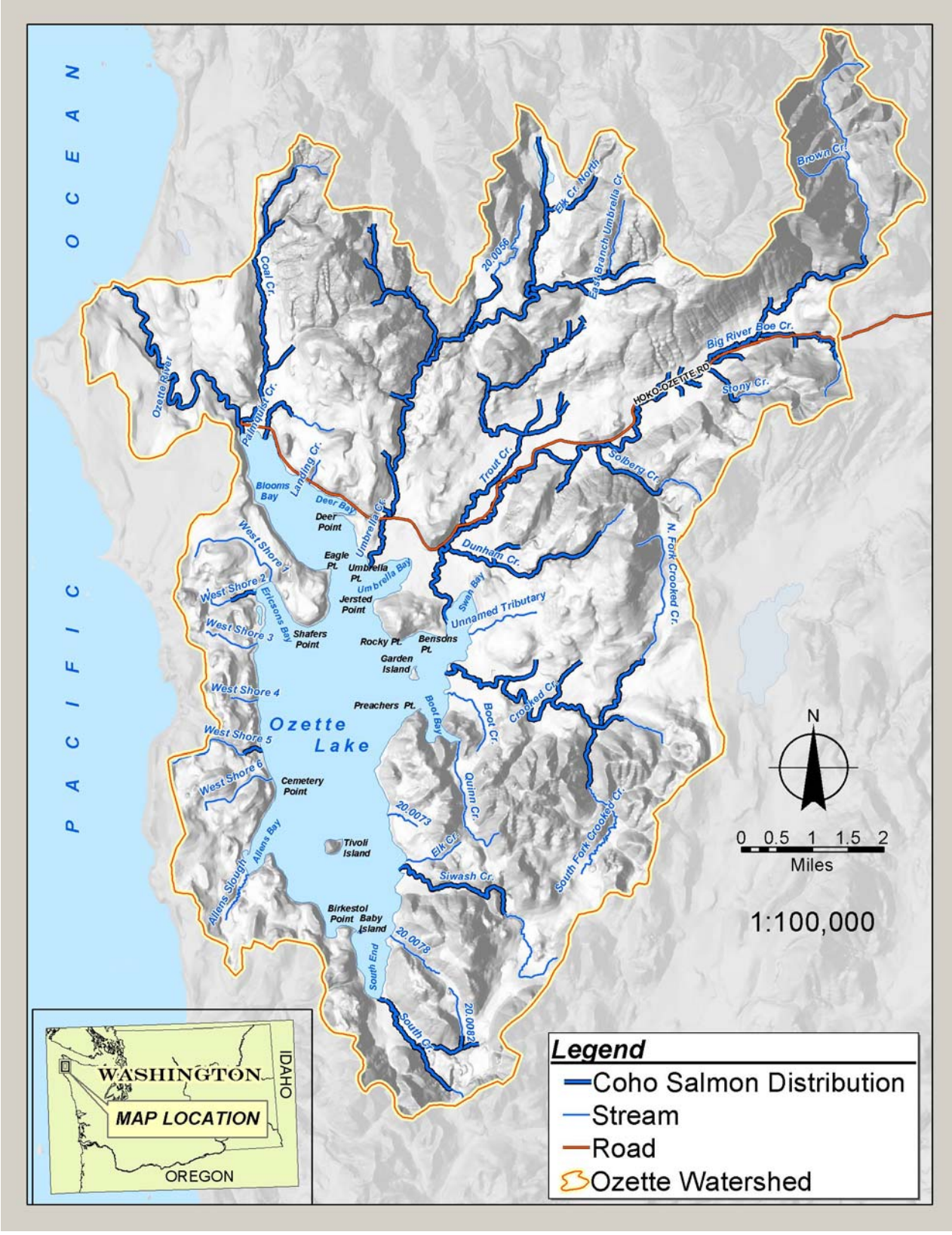

Figure 2.4. Known and presumed coho distribution in the Lake Ozette Watershed (source: MFM, unpublished fish distribution data).

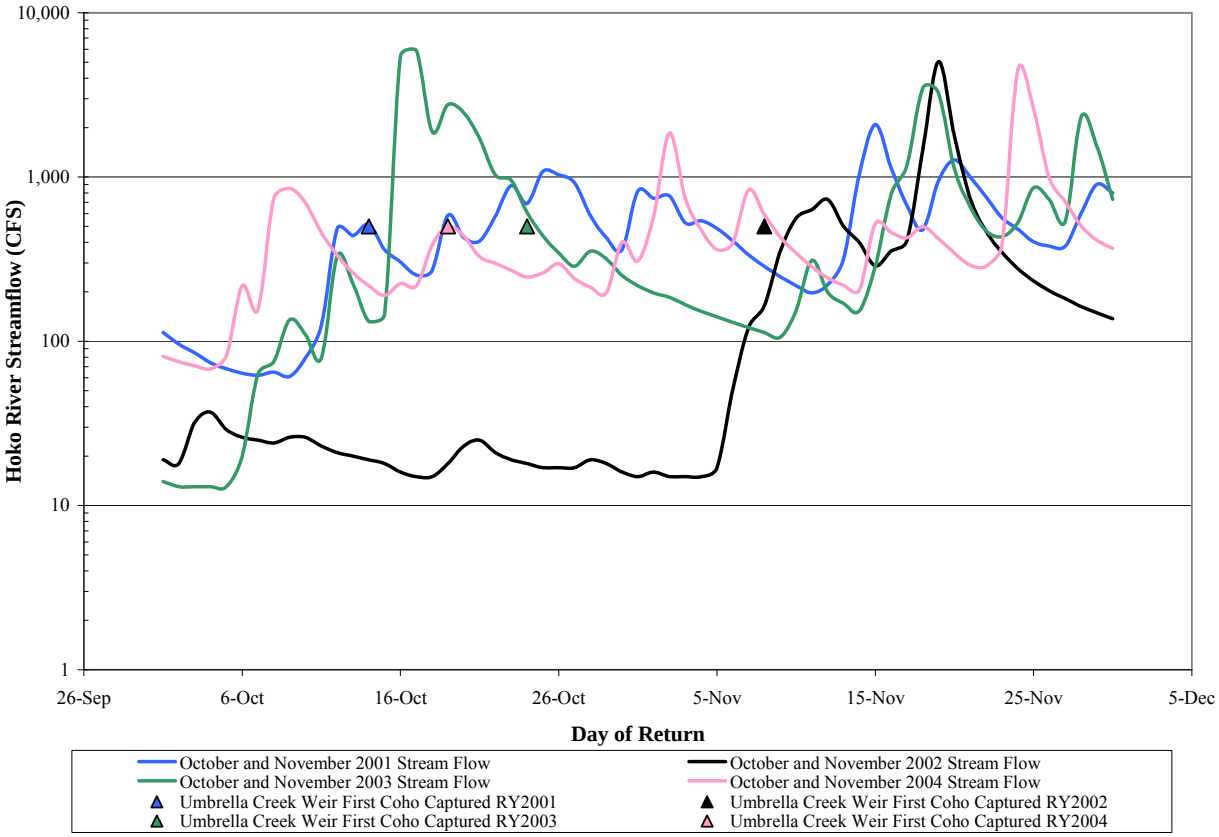

Figure 2.5. Relationship between streamflow[7] and the first coho salmon captured in the Umbrella Creek weir for return years 2001 through 2004 (source: hydrologic data from USGS gage 12043300; biological data from MFM, unpublished weir records).

Coho spawning in Ozette tributaries begins in early to mid-November and extends through mid- to late January. The earliest seasonal records of coho spawning in Ozette tributaries occurred on October 27, 1998 when one coho redd was observed in Big River (MFM unpublished spawning ground data). The latest seasonal observation of coho spawning in Ozette tributaries was observed on January 28, 1983 when 2 spawning coho were observed in Big River between RM 10.81 and 9.4 (MFM spawning ground database, survey conducted by WDFW). The timing of peak coho spawning varies between years. The earliest peak coho counts in Big River occurred on November 25, 1981; the latest peak counts were recorded December 20, 2004. The earliest peak coho counts in Boe Creek occurred on November 25, 1980; the latest peak counts were recorded January 6, 1986. Average peak coho counts for the period of survey record in Big River and Boe Creek occur on December 8 and 14, respectively.

[7]Streamflow data used is from the Hoko River stream gage, which is the nearest long-term stream gage to Umbrella Creek. Complete stream gage data for Umbrella Creek is not available for the entire period of 2001 through 2004. . Umbrella Creek streamflows are significantly lower than Hoko River streamflows, but the relationship between the two streams' relative streamflows is good.

2.1.2.2.4 Coho Salmon Fry Emergence and Dispersal

Only limited monitoring of coho salmon fry emergence and dispersal has occurred in the Ozette watershed. In 1999 and 2001 salmon fry and smolt trapping was conducted in Umbrella Creek. Results of trapping from 1999 suggest that coho salmon emerge from the gravel in March and April (based on egg sacs still attached to fish in late April). There are likely several life history strategies employed by emergent fry. In Umbrella Creek large numbers of fish have been observed rearing in secondary channels or along the margins of the main channel in early spring. Others rapidly migrate downstream from the spawning grounds into the lake or lower reaches of Umbrella Creek. In a period of 24 days from April 14 to May 7, 1999 almost 49,000 age 0 coho were observed moving downstream from RM 1.0 towards the lake (Figure 2.6). Based on sampling on April 20, 2001 at RM 0.7 (Umbrella Creek) it was estimated that 9,300 age 0 coho moved downstream towards the lake in a single day. Snorkel surveys of along the shoreline of the lake near the mouth of Umbrella Creek indicate that numerous coho disperse into the nearshore environment upon entering the lake. Surveys in Swan Bay also detected nearshore dispersal of age 0 coho. Sockeye smolt trapping near the lake outlet routinely detects age 0 coho moving down the Ozette River. In 2001 over 2000 age 0 coho were counted through the smolt trap. Age 0 coho have been observed in spring and early-summer near the lake's outlet and along banks of the Ozette River.

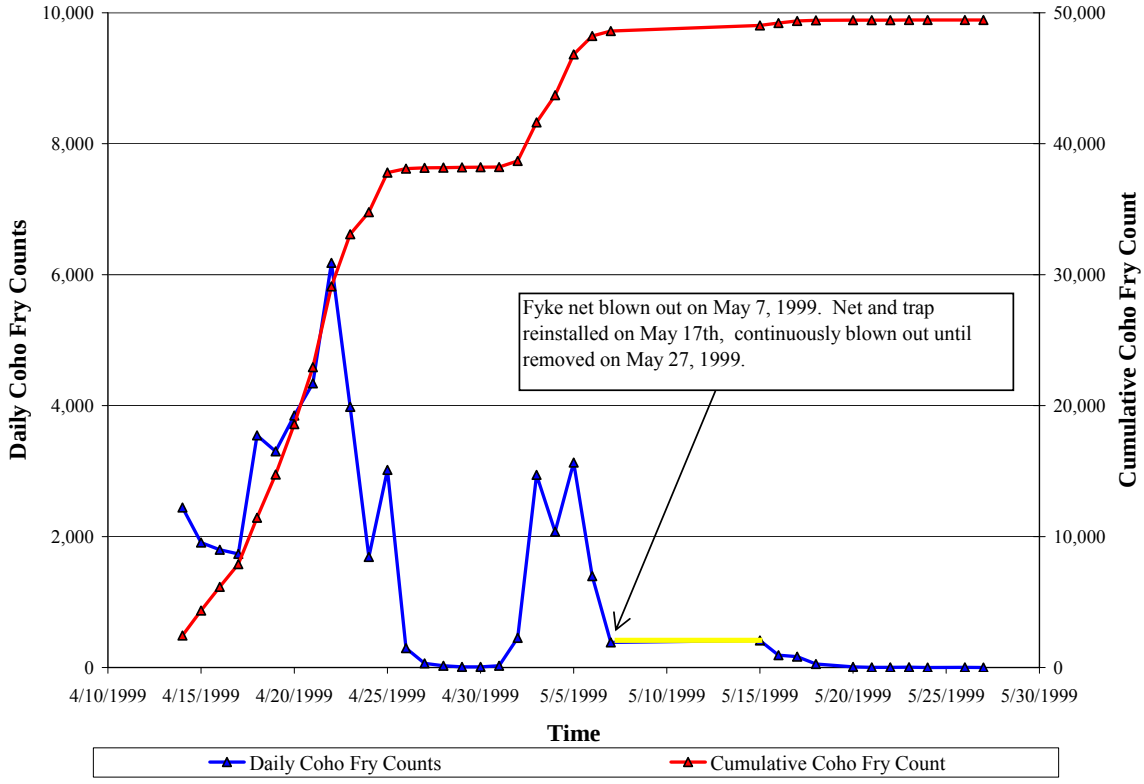

Figure 2.6. Daily and cumulative coho fry counts conducted near RM 1.0 in Umbrella Creek using a winged fyke net during the spring of 1999 (source: MFM, unpublished trap data).

2.1.2.2.5 Juvenile Coho Salmon Freshwater Rearing

Juvenile coho salmon are known to rear in tributaries to Lake Ozette, the Ozette River, tributaries to the Ozette River, and the lake. The degree or proportion of the population that rears in each habitat type is unknown. Seine surveys conducted in Umbrella Creek during early fall 1999 revealed high numbers of age 0 coho rearing pools. In one pool, more than 180 age 0 coho were captured in three passes with a seine net (MFM unpublished juvenile trapping data). Smolt counts from trapping efforts during the spring of 1999 only enumerated 88 age 1+ coho, suggesting that the majority of stream rearing juvenile coho migrate into the lake sometime between fall and early spring and then rear for two to several months before their migration to the Pacific Ocean. Very little data exist on the timing of tributary rearing coho migration into the lake. However, coho have been observed in off-channel habitats throughout the watershed during the winter months, suggesting that at least a component of the population exhibits the more common stream rearing life history traits observed in other coastal watersheds, with downstream migrations beginning in spring.

The life history of age 0 lake-rearing coho salmon remains poorly understood in the Ozette watershed. Wydoski and Whitney (2003) found that lake [reservoir] rearing juvenile coho salmon fed primarily on zooplankton (57-75%), such as *Daphnia*. Jacobs et al. (1996) concluded that there was some potential competition for food with sockeye salmon. In British Columbia, lake dwelling coho stomach contents contained less than 11% (by prey items, 5% by weight) zooplankton (Mason 1974 *in* Sandercock 1991). This may suggest less potential for competition with sockeye, but the diets of Lake Ozette lake-rearing coho have not been investigated. Predation on juvenile sockeye by lake-rearing coho may be a more important interaction than potential competition for food. In Cultus Lake (B.C.), age 0 sockeye were the primary food item for juvenile lake-rearing coho (Sandercock 1991). In Chignik Lake (Alaska) it was estimated that juvenile coho consumed 59% of the average population of sockeye salmon fry during a three-year period (Ruggerone and Rogers 1992). During trapping studies in Umbrella Creek, juvenile coho as small as 1.5 inches (38 mm) were observed preying on emergent sockeye fry (MFM unpublished trapping data).

2.1.2.2.6 Coho Salmon Seaward Migration

No direct attempts to enumerate coho smolt production in the Ozette watershed have been made. Coho smolts are captured during sockeye smolt trapping, but sockeye emigrate earlier than coho, and therefore only partial datasets for coho smolt production are available. Jacobs et al. (1996) provide an estimate of smolt production from trapping conducted in 1992. In 1992, estimated smolt production was 2,562 (95% CI 1,317-3,807) using the standard mark and recapture techniques, or 2,913 (95% 1,736-5,372) using a bootstrap estimation method (Conrad 1993). However, in 1992, smolts were trapped

only during nighttime hours and the period of sampling was only from March 31 to May 14. Thus, these smolt estimates do not reflect total smolt production from the system.

In recent years (2001-2004), peak coho smolt counts have occurred from mid-May to early June. Coho smolts have been captured as early as April 10 (2002) and as late as July 1 (2001). Coho smolt size has averaged 119 mm FL (n=314) during this time period. Since no years contain a full dataset of the emigration time window, it is not possible to accurately produce smolt production estimates. All smolt monitoring periods do contain at least one period of record that overlaps with each of the other years of smolt trapping data. This makes it possible to compare relative proportions of smolts that migrated outside of the monitoring time frame for years where the trap was either pulled early or put in place late in the season. These periods were used to produce emigration proportions for each of the datasets from 2001 through 2004 and to produce general estimates of seasonal smolt production (Table 2.2).

Table 2.2. Ozette River coho smolt trapping periods, total coho smolts counted, expanded counts (based on trap efficiency [TE]), and estimated total coho smolt production (based on estimates for missing periods of the emigration period) (source: MFM, unpublished data).

Year	Start of Trapping	End of Trapping	Total Coho Smolts Counted	Expanded Count for Trap Efficiency	Estimated Coho Smolt Production
2001	5/24/2001	7/1/2001	4,029	13,714	48,782
2002	3/19/2002	5/30/2002	3,609	24,387	35,431
2003	5/13/2003	6/11/2003	2,858	52,899	81,281
2004	4/7/2004	6/1/2004	11,720	78,524	90,602

2.1.2.2.7 Coho Salmon Marine/Ocean Phase

No direct studies have been conducted of Ozette coho salmon marine life histories. It is assumed that Ozette coho behave similarly to other Washington northern coastal coho stocks.

2.1.2.3 Coho Salmon Hatchery Practices and Planting History

Several stock assessment reviews of Ozette coho indicate either no or very limited hatchery releases have occurred (WDF et al. 1994; McHenry et al. 1996; WDFW 2002). However, a query of the Regional Mark Information System (RMIS) reveals this is not the case. Between 1959 and 1980, over 1.6 million juvenile coho salmon were released into the Ozette watershed. Table 2.3 depicts the recorded hatchery releases of coho salmon in the Ozette watershed. Slightly more than 93% of all releases were fry less than 1 gram in weight. In fact only 2% of all coho released were yearling smolts. All coho hatchery releases were discontinued in this watershed in 1980.

Table 2.3. Summary of Ozette Watershed coho hatchery releases (source: RMIS database query 2005)

Brood Year	Release Date	Agency	Hatchery	Broodstock Source	Weight at Release (grams)	Release Site	Number Released
1958	8/4/1959	WDFW	Dungeness	Dungeness	0.68	Big River	139,650
1958	9/18/1959	WDFW	Dungeness	Dungeness	0.75	Big River	152,306
1958	9/27/1959	WDFW	Dungeness	Dungeness	0.8	Big River	124,865
1958	10/6/1959	WDFW	Dungeness	Dungeness	0.75	Big River	159,874
1958	12/29/1959	WDFW	Dungeness	Dungeness	1.53	Big River	74,000
1965	6/7/1967	WDFW	Dungeness	Dungeness	11.94	Big River	28,082
1975	5/7/1976	WDFW	Sol Duc	George Adams	0.5	Siwash Creek	180,000
1976	3/1/1977	WDFW	Sol Duc	George Adams	0.36	Umbrella Creek	200,000
1976	3/1/1977	WDFW	Sol Duc	George Adams	0.36	Big River	200,000
1976	3/2/1977	WDFW	Sol Duc	George Adams	0.36	NF Crooked Creek	100,000
1976	3/3/1977	WDFW	Sol Duc	George Adams	0.36	Siwash Creek	100,000
1976	3/3/1977	WDFW	Sol Duc	George Adams	0.36	Ozette Lake	200,000
1977	4/27/1979	USFWS	Quilcene	Big Quilcene	23.84	Ozette River	2,000
1978	4/29/1980	USFWS	Quilcene	Big Quilcene	22.7	Ozette River	4,500

2.1.2.4 Coho Salmon Genetics

No information is available on this subject.

2.1.3 Chum Salmon (*Oncorhynchus keta*)

Chum salmon are native to the Ozette watershed and are sustained through wild production (WDF et al. 1994). Fall chum salmon in the Ozette watershed have been identified as a distinct stock in recent stock assessments (Nehlsen et al. 1991; WDF et al. 1994; McHenry et al. 1996; WDFW 2002).

2.1.3.1 Current and Historical Abundance

Chum salmon were fairly abundant in the Ozette watershed according to historical catch records. The historical data available for Ozette chum salmon is limited. Figure 2.7 illustrates the trend in chum salmon harvest in the Ozette River between 1948 and 1955. After 1955, chum salmon harvest only appears in the catch records during two years, with a total of three fish landed. The harvest trend data for Ozette gives only a short snapshot of the historical population size, but clearly shows that the number of chum salmon harvested declined in the Ozette River while chum harvest remained stable or increased in the other nearby watersheds. Since the 1950s, observations of chum salmon in the Ozette system are very limited.

A few chum salmon have been observed transiting the weir in mid- or late August. Spawning ground surveys in the watershed detect chum salmon only on some years. Factors contributing to the decline of the Ozette fall chum stock remain poorly understood. Recent stock assessment reports describe the stock status as either critical, threatened, or unknown (WDF et al. 1994; WDFW 2002; Nehlsen et al. 1991; McHenry et al. 1996). Nehlsen et al. 1991 describe the Ozette chum population as potentially extinct. The Lake Ozette chum run was once at least a thousand or more fish, while current run sizes are most likely less than 25 or 50 fish.

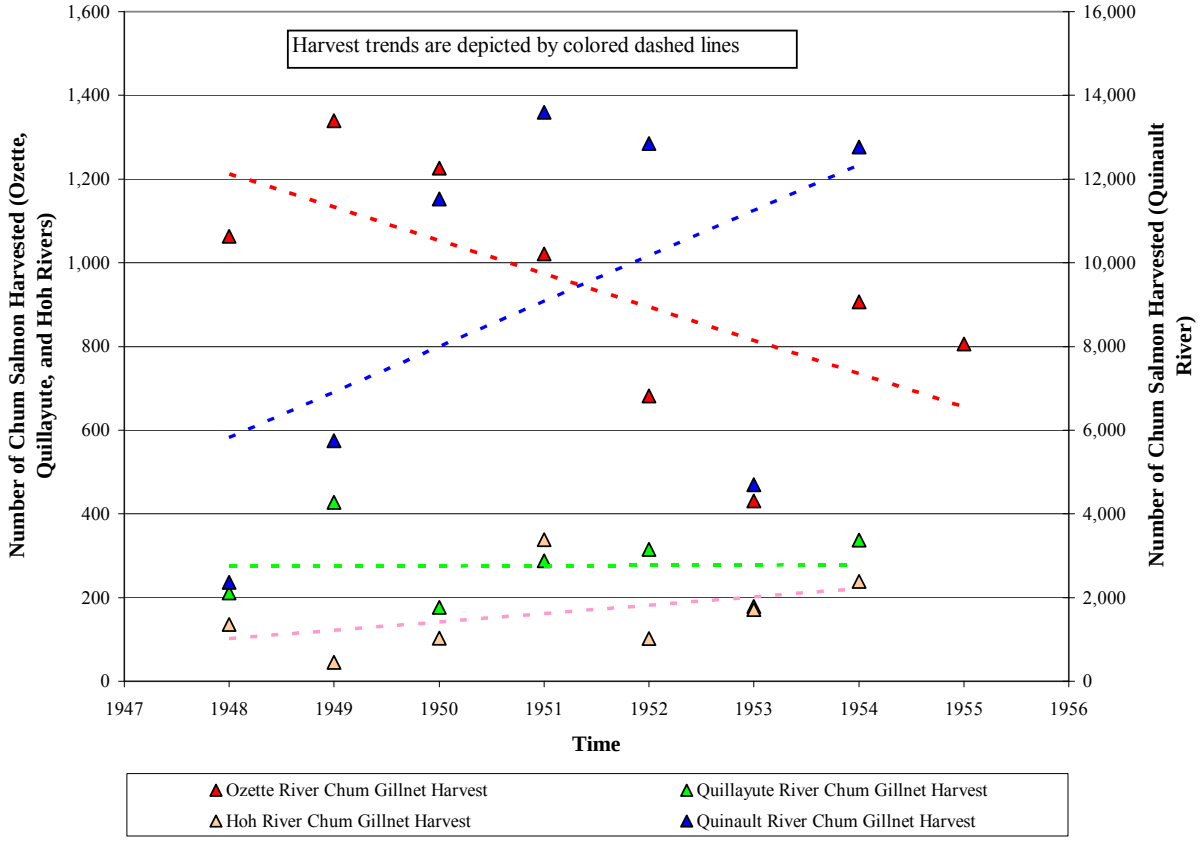

Figure 2.7. Chum salmon harvest from gillnets fishing Ozette River (1948-1955) contrasted with chum salmon harvest from nearby Olympic Peninsula rivers (source: WDF 1955; Dlugokenski et al. 1981).

2.1.3.2 Chum Salmon Life History

2.1.3.2.1 Adult Chum Entering System

Adult chum salmon enter the Ozette system between October and early December (WDF et al. 1994). Historically, peak harvest occurred between October and December (WDF 1955). Occasionally chum salmon are observed transiting the weir in mid- or late

August. Little else is known about the historical and/or current migration pattern of chum salmon in the Ozette watershed.

2.1.3.2.2 Adult Chum Holding in Lake Ozette

No information is available on this subject. It is assumed that some chum salmon that enter the system spawn downstream of the lake and therefore do not hold in the lake. Chum salmon have been observed on Allen's Beach (1988 and 2002), but records are not available for all years. It is assumed that most chum salmon spawning in the tributaries have a brief holding period in the lake prior to migrating to the spawning grounds. Chum salmon observed entering the lake in August (RY 1999, 2001, and 2003) must hold for at least a few months in the lake prior to spawning.

2.1.3.2.3 Adult Chum Migration and Spawning

Very little is known about the historical spawning distribution of chum salmon in the Ozette watershed. WDF et al. (1994) describe the spawning distribution as the Ozette River, Big River, Umbrella Creek, and Crooked Creek. Very limited spawning ground surveys have been conducted in the Ozette River. The Ozette River is inaccessible from late fall through winter for spawning ground surveys because of high streamflows and is nearly impossible to survey from the banks due to the size and depth of the river, dense riparian vegetation, and the lack of a trail (Jacobs et al. 1996). Fairly detailed data from spawning ground surveys are available for Ozette tributaries for return year (RY) 1974-1990 and limited data from RY 1991 through 1997, and more detailed data for Ozette tributaries from RY 1998 to present. A review of approximately 1,150 spawning ground surveys conducted from 1970-2004 included only 8 observations of chum salmon. There have been 6 observations in Umbrella Creek occurring in return years 1996, 1999, 2000, and 2004. In 1993 there was one observation in Crooked Creek and one in the South Fork Crooked Creek. A total of six chum were captured in the Umbrella Creek weir in return years 2002 (3), 2003 (1), and 2004 (2). One spawned-out chum carcass was found on Allen's Beach on December 5, 2001. Chum salmon were also observed on Allen's Beach in 1988.

2.1.3.2.4 Chum Salmon Fry Emergence and Dispersal

Very little information is available on this subject. The limited number of spawners makes encounters infrequent in the watershed. No juvenile salmonid monitoring has occurred downstream of spawning habitat in the Ozette River, limiting smolt and fry trapping to the tributary spawning component of the run. During fry trapping in Umbrella Creek in 1999, a total of 13 chum salmon fry were captured in early May, apparently migrating to the lake.

2.1.3.2.5 Juvenile Chum Salmon Freshwater Rearing

No information is available on this subject. It is assumed that chum fry rapidly migrate from the spawning grounds to the lake and then to the river. Some feeding may occur in the lake and tributaries.

2.1.3.2.6 Chum Salmon Seaward Migration

Very little information is available on this subject. In recent years juvenile chum salmon have regularly been caught in the Ozette River smolt trap. The sockeye smolt trap is not designed to enumerate emigrating Age 0 salmonids, and counting methods have varied between and within monitoring seasons. During trapping in 2001 through 2004, juvenile chum counts ranged from 1 (2002) to 445 (2004. Note: chum and Chinook not differentiated in all counts, but the majority of fish were juvenile chum salmon). Peak counts have been observed from mid-April to mid-May. Juvenile chum have been captured in the smolt trap into late June.

2.1.3.2.7 Chum Salmon Marine/Ocean Phase

It is assumed that chum salmon in the Ozette system have similar migrations and feeding patterns as other nearby stocks.

2.1.3.3 Chum Salmon Hatchery Practices and Planting History

No records of chum salmon hatchery plants were found for the Ozette drainage. It is therefore assumed that no stocking has occurred within the basin.

2.1.3.4 Chum Salmon Genetics

No information is available on this subject.

2.1.4 Chinook Salmon (*Oncorhynchus tshawytscha*)

Chinook salmon are native to the Ozette watershed (WDF 1955; Nehlsen et al. 1991; McHenry et al. 1996) and were historically sustained through wild production. Fall Chinook salmon in the Ozette watershed have not been identified as a distinct stock in recent stock assessments conducted by WDFW (WDF et al. 1994; WDFW 2002).

2.1.4.1 Current and Historical Abundance

Chinook salmon were abundant in the Ozette watershed according to historical catch records. The historical data available for Ozette Chinook salmon are limited. Figure 2.8, illustrates the trend in Chinook salmon harvest in the Ozette River between 1948 and 1958. After 1958, Chinook salmon harvest appears in the catch records only during 6 years, with a total of 40 fish landed. The harvest trend data for Ozette give only a short snapshot of the historical population size but clearly shows that the number of Chinook salmon harvested declined in the Ozette River while Chinook harvest remained stable or increased in the other nearby watersheds. Reported harvest from 1948 to 1951 in the Ozette River is slightly higher than the harvest during the same years in the Hoh River, suggesting that the run was fairly sizable before the population collapse. Since the 1950s, observations of Chinook salmon in the Ozette system are very limited. No Chinook salmon have been observed transiting the adult weir in the Ozette River. Spawning ground surveys in the watershed have not detected Chinook salmon in recent times (1977-2004). Factors contributing to the decline of the Ozette fall Chinook stock remain poorly understood.

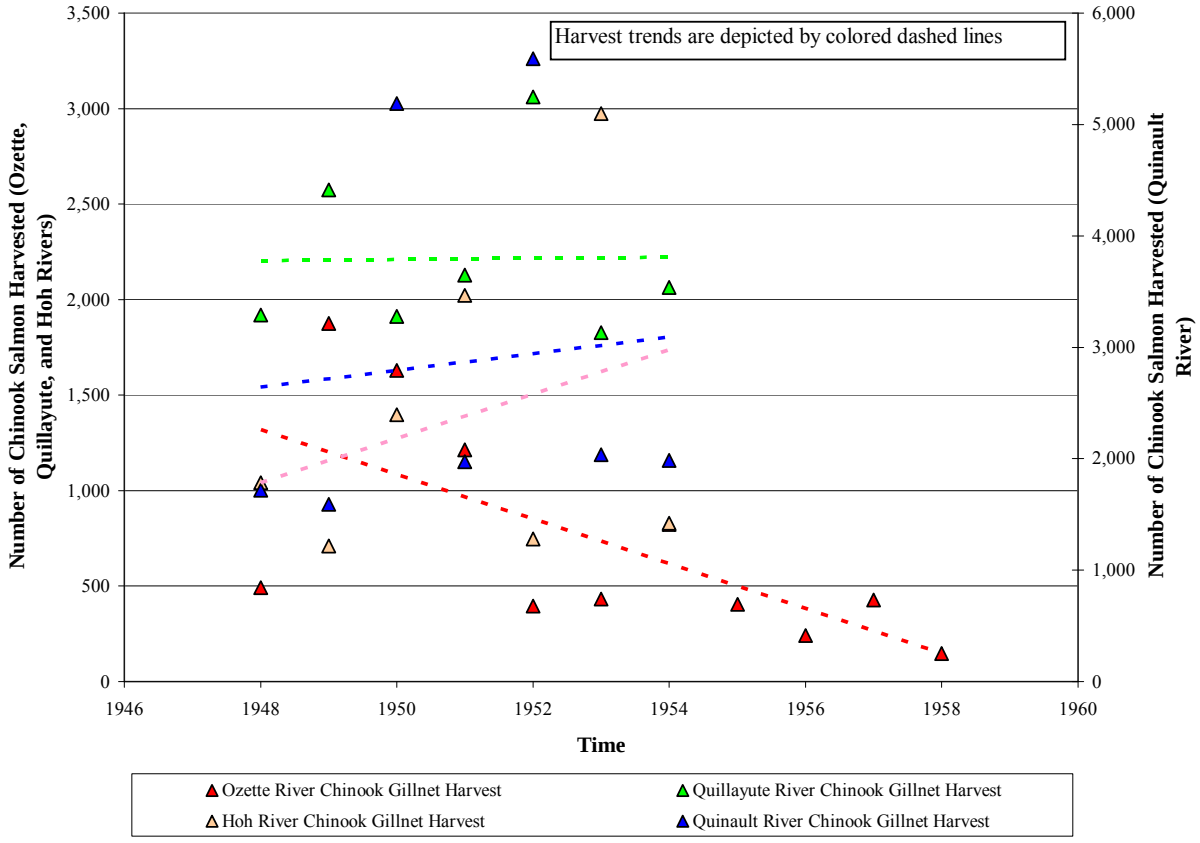

Figure 2.8. Chinook salmon harvest from gillnets fishing the Ozette River (1948-1958) contrasted with Chinook salmon harvest data from nearby Olympic Peninsula rivers (source: WDF 1955; Dlugokenski et al. 1981).

Recent stock assessment reports describe the stock status as either critical or extinct (WDF et al. 1994; Nehlsen et al. 1991; McHenry et al. 1996). Nehlsen et al. (1991) describe the Ozette Chinook population as potentially extinct. WDF et al. (1994) describe the stock as extinct or not currently verifiable within the system. The Lake Ozette Chinook run was once at least 2,000 or more fish; current run sizes are most likely less than 10 to 20 Chinook.

2.1.4.2 Chinook Salmon Life History

2.1.4.2.1 Adult Chinook Entering System

The current abundance of Chinook salmon is so low in the Ozette watershed that information on run timing is nonexistent. Historically, peak harvest occurred between September and October (WDF 1955). Little else is known about the historical and/or current migration pattern of Chinook salmon in the Ozette watershed.

2.1.4.2.2 Adult Chinook Holding in Lake Ozette

No information is available on this subject. It is assumed that some Chinook salmon that enter(ed) the system spawn downstream of the lake and therefore do not hold in the lake. In recent years only one observation of adult Chinook salmon holding in the lake could be found. One adult Chinook was electro-fished from the lake on October 7, 2004 but information on the location within the lake is not available (WOE 2005). It is assumed that most Chinook salmon spawning in the tributaries have a brief holding period in the lake prior to migrating to the spawning grounds.

2.1.4.2.3 Adult Chinook Migration and Spawning

As discussed earlier, no Chinook have been observed spawning in Lake Ozette tributaries in recent years (1977-2004). Phinney and Bucknell (1975) report that Chinook spawning occurs in the Ozette River and in Big River.

2.1.4.2.4 Chinook Salmon Fry Emergence and Dispersal

Very little information is available on this subject. The lack of spawners makes encounters infrequent in the watershed. No juvenile salmonid monitoring has occurred downstream of spawning habitat in the Ozette River, limiting smolt and fry trapping to the tributary spawning component of the run. During fry trapping in Umbrella Creek in 1999 no Chinook salmon fry were captured.

2.1.4.2.5 Juvenile Chinook Salmon Freshwater Rearing

No information is available on this subject. It is assumed that Chinook fry rapidly migrate from the spawning grounds to the lake and then to the river. Some feeding may occur in lake and tributaries.

2.1.4.2.6 Chinook Salmon Seaward Migration

Very little information is available on this subject. In recent years juvenile Chinook salmon have been captured in the Ozette River smolt trap. The sockeye smolt trap is not designed to enumerate emigrating Age 0 salmonids and counting methods have varied between and within monitoring seasons. During trapping in 2001 through 2004, juvenile Chinook were observed only in 2003 and 2004, and only in low numbers (less than 50 fish). It is possible that low numbers of Chinook were captured in 2001 and 2002 but not correctly identified and/or recorded.

2.1.4.2.7 Chinook Salmon Marine/Ocean Phase

It is assumed that Chinook salmon in the Ozette system have/had similar migrations and feeding patterns as other Washington northern coastal stocks.

2.1.4.3 Chinook Salmon Hatchery Practices and Planting History

The relatively high numbers of Chinook salmon in the reported gillnet catch followed by a complete collapse in the fishery warrants discussion of the potential influence of hatchery stocking in the watershed. Extensive hatchery releases occurred in the nearby Hoko River in the years following the highest Chinook catches reported for the Ozette River. A review of hatchery release records was conducted to determine whether hatchery stocking may have affected the peak Chinook harvests reported for the Ozette River. However, there are no records of Chinook salmon being released into the Ozette watershed and therefore it is unlikely that hatchery releases influenced harvest of Chinook salmon in the Ozette River.

2.1.4.4 Chinook Salmon Genetics

No information is available on this subject.

2.1.5 Steelhead/Rainbow Trout (*Oncorhynchus mykiss*)

Steelhead trout are native to the Ozette watershed and are sustained through wild production (WDF et al. 1994; McHenry et al. 1996; WDFW 2002). Steelhead/rainbow trout primarily occur in the form of winter-run steelhead, but non-anadromous forms of the species may also be present. Winter-run steelhead in the Ozette watershed have been identified as a distinct stock in recent stock assessments conducted by WDFW (WDF et al. 1994; WDFW 2002). Within the context of this report, the term steelhead will be used when describing the species *O. mykiss*.

2.1.5.1 Current and Historical Abundance

No current or historical abundance data are available for this stock. The status and trend of this stock are unknown (WDF et al. 1994; McHenry et al. 1996; WDFW 2002). Only anecdotal evidence of their historical abundance exists. Kemmerich (1926) reports that old-time residents of the lake informed him that steelhead enter the lake system in considerable numbers. A review of sport harvest data (1993-2002) indicates that fewer than 20 steelhead are harvested annually in the Ozette system (WDFW 1994; WDFW 1997; WDFW 1999a; WDFW 1999b; WDFW 1999c; WDFW 1999d; WDFW 2004a; WDFW 2004b). The majority of harvest occurs in the Big River and the majority of fish reported on catch record cards are of hatchery origin[8] (WDFW 1994; WDFW 1997; WDFW 1999a; WDFW 1999b; WDFW 1999c; WDFW 1999d; WDFW 2004a; WDFW 2004b).

2.1.5.2 Steelhead Trout Life History

2.1.5.2.1 Adult Steelhead Trout Entering System

Data regarding adult steelhead entry timing into watershed are limited. Steelhead captures in the adult weir in Umbrella Creek indicate that adult steelhead must begin entering the Ozette River in early-November and potentially earlier.

2.1.5.2.2 Adult Steelhead Trout Holding in Lake Ozette

Very little information is available regarding adult holding in the lake. Adult steelhead are sometimes caught by sport fishers in the lake.

[8] Hatchery-origin steelhead reported as harvested from Big River are assumed to be hatchery strays from nearby hatcheries (Quillayute, Sooes, Hoko).

2.1.5.2.3 Adult Steelhead Trout Migration and Spawning

Steelhead have been observed entering Ozette tributaries as early as late October (Umbrella Creek) and increase in abundance as the spawning season progresses. Weir operations at Umbrella Creek from 2001 to 2004 have enumerated a total of 8 steelhead migrating upstream before December. Steelhead have been observed spawning as early as late November in Big River and as late as mid-June in Coal Creek. However, less than 2% of all redds detected in the watershed are detected in the months of November, December, and June. Just over 95% of all redds detected have been detected in February (12.5%), March (24.6%), April (44.4%), and May (13.5%). Based on data collected from 1987 to 2001, peak spawning was determined to take place between late March and mid-April. The primary streams used for spawning include the Ozette River, Umbrella Creek, Big River, and Crooked Creek. Additional spawning also occurs in other accessible tributaries such as the North and South Forks Crooked Creek, Coal Creek, West Branch Umbrella Creek, and Boe Creek. Spawning ground survey data are somewhat limited in the Ozette watershed; a total of 216 steelhead surveys were reviewed as part of this assessment. Redds per mile surveyed averaged 0.56 redds/mi in the smaller streams (60 surveys) and 1.32 in the larger streams (156 surveys). Big River contains the largest spawning aggregation in the watershed as well as the highest number of steelhead spawning ground surveys. A summary of Big River spawning ground survey data for the period of record is shown in Figure 2.9.

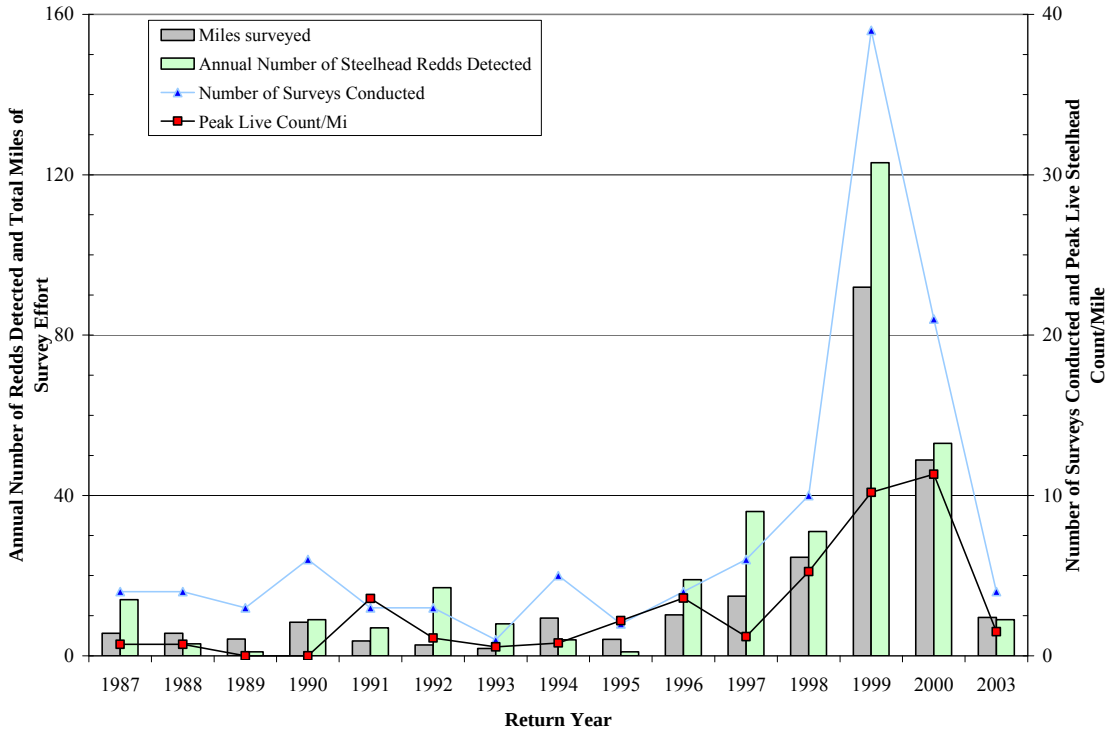

Figure 2.9. Summary of mainstem Big River steelhead spawning ground survey data from RYs 1987 through 2003, excluding RYs 2001 and 2002, when no data were collected (source: MFM, unpublished spawning ground survey data).

2.1.5.2.4 Steelhead Trout Fry Emergence and Dispersal

Winter-run steelhead have a protracted spawning season, and therefore their emergence timing also extends across several months. Emergence likely begins in mid-March for some individuals and extends into August for others. The first age 0 steelhead encountered during trapping studies in Umbrella Creek in 1999 was on April 20. Less than 100 age 0 steelhead were encountered between April 15 and May 27, when the trap was destroyed. The trap was repaired and reinstalled on June 22, 1999. Based upon data collected during the second round of trapping in 1999, it is thought that peak emergence timing and dispersal occurred from mid-June to mid-July. Over 8,200 age 0 steelhead were enumerated migrating downstream of the Hoko-Ozette Road Bridge towards Lake Ozette.

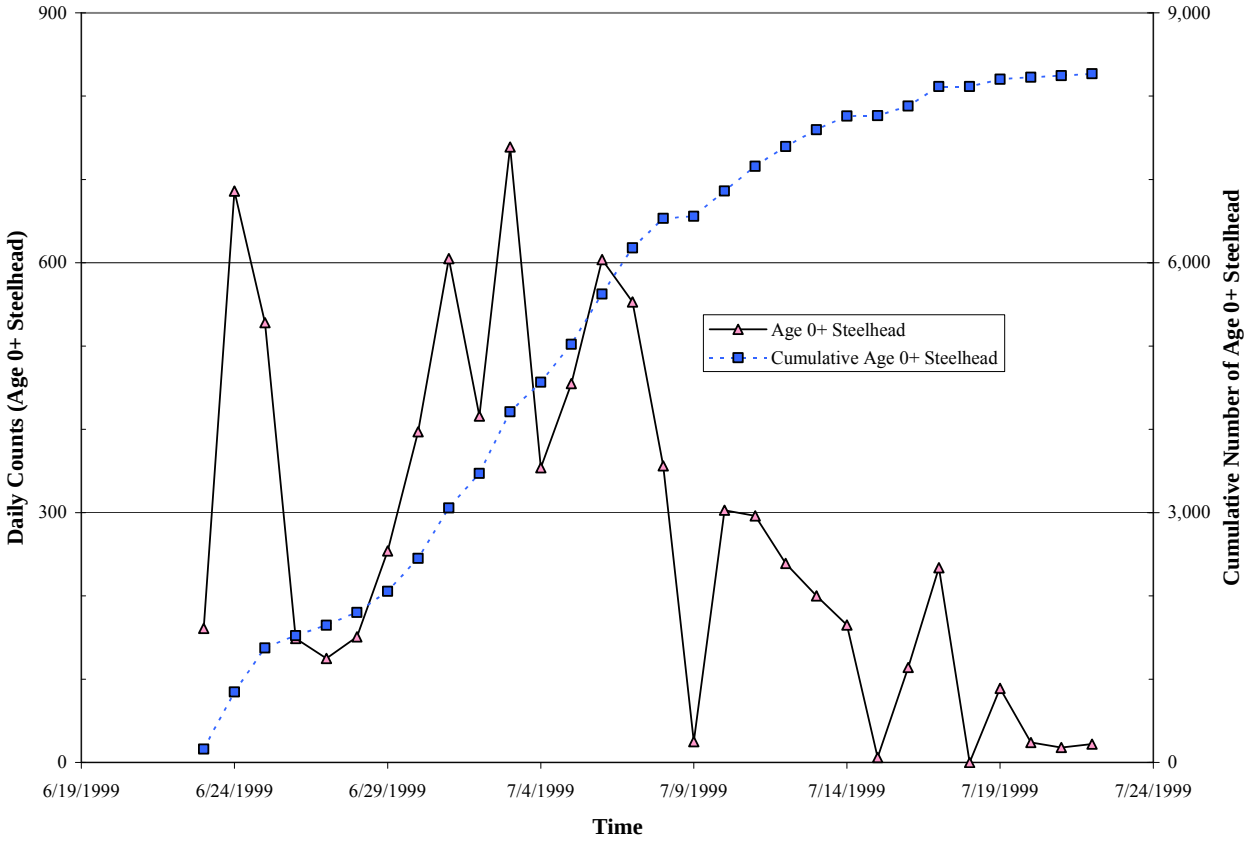

Figure 2.10. Daily and cumulative steelhead fry counts conducted near RM 0.8 in Umbrella Creek using a winged fyke net during the summer of 1999 (source: MFM, unpublished trap data).

2.1.5.2.5 Juvenile Steelhead Trout Freshwater Rearing

Very few data are available regarding juvenile steelhead freshwater rearing. Based upon trapping studies conducted in Umbrella Creek, it is possible that some juvenile rearing occurs in the lake. All other rearing occurs in accessible tributaries to the lake, or Ozette River. It is assumed that steelhead typically rear for one to three years prior to emigration. The majority of Washington steelhead smolts migrate at age 2 (Wydoski and Whitney 2003).

2.1.5.2.6 Steelhead Trout Seaward Migration

No directed attempts to enumerate steelhead smolt production in the Ozette watershed have been made. Steelhead smolts are captured during sockeye smolt trapping, but the period of the sockeye emigration is much shorter than the steelhead migration period and therefore only partial datasets for steelhead smolt production are available. In recent years (2001-2004), peak steelhead smolt counts have occurred from mid-April to early June. Steelhead smolts have been captured as early as April 13 (2002) and as late as July 1 (2001). No length or age data were collected for steelhead smolts during this period. Since no years contain a full dataset of the emigration time window, it is not possible to accurately produce smolt production estimates. All smolt monitoring periods do contain at least one period of record that overlaps with each of the other years of smolt trapping data. This makes it possible to compare relative proportions of smolts that migrated outside of the monitoring time frame for years where the trap was either pulled early or put in place late in the season. These periods were used to produce emigration proportions for each of the datasets from 2001 through 2004 and to produce general estimates of seasonal smolt production (Table 2.4).

Table 2.4. Ozette River steelhead smolt trapping periods, total steelhead smolts counted, expanded counts (based on trap efficiency), and estimated total steelhead smolt production (based on estimates for missing parts of the emigration period) (source: MFM, unpublished trap data).

Year	Start of Trapping	End of Trapping	Total Steelhead Smolts Counted	Expanded Count for Trap Efficiency	Estimated Steelhead Smolt Production
2001	5/24/2001	7/1/2001	170	543	4,784
2002	3/19/2002	5/30/2002	255	1,720	2,117
2003	5/13/2003	6/11/2003	87	1,652	6,667
2004	4/7/2004	6/1/2004	395	2,647	2,852

Unlike salmon, steelhead trout are iteroparous and may make several migrations from salt to freshwater to spawn. Upon spawning, some steelhead die but many survive. Those

that survive spawning must then migrate back to the ocean. During this life history phase, steelhead are called kelts. Kelts are routinely observed transiting the adult sockeye weir and have also been captured during smolt trapping activities. There have been no attempts to quantify the total number of kelts migrating down the Ozette River, but most observations during smolt trapping and adult sockeye enumeration are recorded. A review of these records indicates that most kelts move down from the lake during the month of May. Smolt trapping in 2001, 2002, 2003, and 2004 captured 4, 2, 0, and 0 kelts respectively. All kelts captured during smolt trapping occurred between April 20 (2002) and June 7 (2001). Steelhead observations at the adult sockeye weir have been far more numerous then captures. From 1999 through 2002, a total of 648 steelhead observations were made at the weir. Table 2.5 depicts a summary of all adult steelhead observations at the weir. Note that some of the observations included are adults migrating upstream, but most are kelts migrating downstream.

Table 2.5. Summary of adult steelhead observations at the Ozette River counting weir from 1999 through 2002 (source: MFM, unpublished sockeye weir data).

Year	Start of Weir Operations	End of Weir Observations	Number of Steelhead Observations	First Steelhead Observation	Last Steelhead Observation
1999	4/30/1999	8/6/1999	34	5/3/1999	5/27/1999
2000	4/19/2000	8/12/2000	112	4/19/1999	7/14/2000
2001	4/30/2001	8/18/2001	50	5/1/2001	5/24/2001
2002	4/11/2002	8/14/2002	452	4/11/2002	6/21/2002

2.1.5.2.7 Steelhead Trout Marine/Ocean Phase

No information is available on this subject.

2.1.5.3 Steelhead Trout Hatchery Practices and Planting History

A query of the RMIS (2005) database indicates that no steelhead hatchery releases have occurred in this watershed. No release history is included in any of the stock assessment documents pertaining to the Ozette watershed (see WDF et al. 1994; McHenry et al. 1996; WDFW 2002).

2.1.5.4 Steelhead Trout Genetics

No information is available on this subject. No genetic analysis was been conducted on this stock (WDFW 2002).

2.1.6 Coastal Cutthroat Trout (*Oncorhynchus clarki*)

Coastal cutthroat trout are native to the Ozette watershed and are sustained through wild production (WDFW 2000). Coastal cutthroat trout in the Ozette watershed have been identified as a distinct stock complex based upon the geographic distribution of their spawning grounds (WDFW 2000).

2.1.6.1 Current and Historical Abundance

There are no current or historical abundance data for Ozette coastal cutthroat. The status of the stock complex is unknown (WDFW 2000). Beauchamp et al. (1995) speculated that 5,000 to 10,000 large (>300mm) cutthroat trout might reside in Lake Ozette. There are limited data regarding incidental captures of coastal cutthroat in Section 2.1.6.2.

2.1.6.2 Coastal Cutthroat Trout Life History

In general, coastal cutthroat trout exhibit four discrete life history forms: sea-run/anadromous, adfluvial, fluvial, and resident (Johnson et al. 1999). Little is known about the life histories displayed by coastal cutthroat trout in the Ozette watershed. WDFW (2000) speculated that the life history in Ozette is likely similar to that observed in Bear Creek (a tributary to the nearby Bogachiel River). While this is likely true for some segments of the population, it is likely not the case for the most significant component of the cutthroat population. Major differences exist between habitat types in the Bogachiel/Quillayute watershed and Lake Ozette. Lake Ozette, being the third largest natural lake in Washington State, provides a different habitat than the Bogachiel/Quillayute watershed. Fish within the watershed surely have adapted to take advantage of the unique lake habitat. Dlugokenski et al. (1981) captured a total of 209 cutthroat trout in Lake Ozette and stated that both resident and sea-run cutthroat were present within their sample. Dlugokenski et al. (1981) identified the adfluvial form of cutthroat trout as resident cutthroat trout (likely just a difference in terminology). It seems likely that the Ozette coastal cutthroat stock consists of three discrete life history types: sea-run/anadromous, adfluvial, and resident. The fluvial life history type of cutthroat trout may also exist in Ozette, but the small tributaries feeding the lake may not provide the habitat types required by this form of coastal cutthroat trout.

2.1.6.2.1 Sea-Run/Anadromous Cutthroat Trout

Emigrating and resident cutthroat trout are commonly captured during smolt trapping operations in the Ozette River (including cutthroat kelts). During spring sockeye smolt trapping from 2001 through 2004, a total of 207 cutthroat juvenile emigrants/kelts were captured (in approximately 209 days trapping effort). Based upon this very limited data, the number of emigrants appears higher in June than in April and May, although trapping efficiency varied by year and month. In S.E. Alaska streams, most emigrants move to

salt water from mid-April to September (Wydoski and Whitney 2003). In Sand Creek (Oregon) cutthroat trout emigrate from January through June, but the majority (87%), migrate between April and June (Wydoski and Whitney 2003). Kelts return to salt water between March and early-April in Oregon and Washington streams, typically about 1 month prior to peak smolt emigration (Trotter 1989). Age at smolt emigration for cutthroat trout in tributaries to the Clearwater River (Olympic Peninsula) mostly appears to be 3 and 4 years, based on scale analysis of spawning fish (Fuss 1984).

Time spent in the estuary or at sea is highly variable for sea-run cutthroat trout, some spending as little as seven days or as many as 158 days (Petersburg Creek, S.E. Alaska; Wydoski and Whitney 2003). On average, sea-run cutthroat spend about 90 days at sea. While at sea, fish typically stay close to shore and do not make the extensive migrations seen with other anadromous salmonids (Trotter 1989). There are no records of sea-run cutthroat over-wintering at sea (Wydoski and Whitney 2003). Some cutthroat trout have been observed over-wintering in non-natal streams, but apparently these entries are not associated with spawning.

Adult sea-run cutthroat trout have been observed entering the Hoh and Clearwater Rivers as early as July, but most fish probably enter freshwater in September and October (Fuss 1984). Upon entering the Ozette River, fish may hold in the mainstem of the Ozette River or directly enter the lake or tributaries. Spawn timing of sea-run cutthroat trout on the Olympic Peninsula is typically between February and March (Fuss 1984). In an unnamed tributary to Nolan Creek (Hoh River, Olympic Peninsula) sea-run cutthroat have been observed spawning during the first week of January (Haggerty 2004B). The spawning distribution of sea-run cutthroat is not documented in the Ozette watershed but is likely similar to that observed in other nearby watersheds where cutthroat seek out small headwater tributaries for spawning.

2.1.6.2.2 Adfluvial Cutthroat Trout

Little is known about the adfluvial cutthroat trout population in Lake Ozette. Trotter (1989) describes this life history type of cutthroat trout to behave similarly to that of sea-run cutthroat trout, spending 1 to 3 years rearing in tributaries before migrating to the lake. Little research has been conducted on the tributary portion of the lives of adfluvial cutthroat populations (Trotter 1989). In food web studies conducted by Dlugokenski et al. (1981) and Beauchamp and LaRiviere (1993), no attempt to distinguish between sea-run and adfluvial cutthroat trout was made. For the purpose of this summary, their findings with respect to life history, feeding, and population structure will be considered to be for the adfluvial type of cutthroat trout. Dlugokenski et al. (1981) examined the stomach contents of 98 cutthroat trout captured and determined that the diet consisted of terrestrial insects (76%), aquatic insects (13%), fish (8%), and benthic invertebrates (4%). The fish consumed by cutthroat trout consisted of equal portions of yellow perch, sculpin, peamouth, and sockeye/kokanee. Northern pike minnow and coho salmon were eaten at a frequency of about one-half of the other three species. Nearly half of the fish remains found in stomach contents were unidentified fish. Dlugokenski et al. (1981) assumed a

maximum of 4% of the cutthroat trout diet consisted of sockeye/kokanee salmon. However, the sampling design focused on the near-shore environment; thus, cutthroat trout in the limnetic zone were not included in the study. Beauchamp and LaRiviere (1993) found significantly different diets in the cutthroat they captured and examined. The authors did not clearly describe the actual stomach contents they examined, but stated that during spring, nearly 40% of the diet of cutthroat trout > 300mm FL was age-0 and age-1 O. *nerka*, while juvenile coho salmon made up 0% of the diet. The total number of fish sampled is also not clearly indicated, but in the methods section the authors describe sampling 15 fish <300 and >300 mm FL of each species. As with sea-run cutthroats, the spawning distribution of adfluvial cutthroat is not documented in the Ozette watershed but is likely similar to that observed in other nearby watersheds where cutthroat seek out small headwater tributaries for spawning

2.1.6.2.3 Resident (Non-Migratory) Cutthroat Trout

The resident life history form does not typically undertake significant migrations but simply maintains a small home territory (Johnson et al. 1999). The resident life history form differs significantly from the anadromous form. Most importantly, resident cutthroat populations are typically isolated from one another spatially. In WDFW (2000), the authors speculate that the later spawn timing (April-May) of resident cutthroat further isolates them from the anadromous form. Little is known about the specifics of this life history type within the Ozette watershed other than that it can be found in most perennial streams with gradients less than about 20%. Little interaction between resident non-migratory cutthroat trout and anadromous salmonids is thought to occur within the watershed.

2.1.6.3 Coastal Cutthroat Trout Hatchery Practices and Planting History

There are no hatchery plants of anadromous or resident cutthroat trout in the Ozette watershed (WDFW 2000). No records of past hatchery plants into Lake Ozette have been found.

2.1.6.4 Coast Cutthroat Trout Genetics

The number of genetically distinct stocks within the Ozette stock complex is unknown; genetic sampling and analysis are needed in order to determine the genetic composition of the stock complex (WDFW 2000).

2.2 NATIVE NON-SALMONID FISH POPULATIONS

Native non-salmonid fish populations in the Lake Ozette watershed are speckled dace, four types of sculpins, Western and Pacific lamprey, threespine stickleback, Olympic mudminnow, peamouth, northern pikeminnow, and redside shiner.

2.2.1 Speckled Dace (*Rhinichthys osculus*)

Little is known about the presence and distribution of speckled dace in the Ozette watershed. Mongillo and Hallock (1997) concluded that they are likely present within the watershed and include them in the map depicting the range of speckled dace on the Olympic Peninsula. Mongillo and Hallock (1997) did not capture speckled dace at their sample sites within the Ozette watershed but concluded that they were likely present based upon captures in the nearby Dickey River watershed. Speckled dace are primarily associated with stream bottoms. Their food sources are typically of benthic origin (Wydoski and Whitney 2003). They are not considered to be competitors with sockeye in the Lake Ozette watershed and are only presumed to be present.

2.2.2 Sculpins (*Cottus Spp*)

Little is known about the presence, distribution, or abundance of sculpins in the Ozette watershed. To date only three species of sculpin have been positively identified in the Ozette watershed; prickly, riffle, and reticulate sculpin. However, there has not been a systematic search including species identification conducted. Mongillo and Hallock (1997) did not capture coastrange, riffle, or torrent sculpins at their sample sites within the Ozette watershed but concluded that they were potentially present based upon captures in the nearby Dickey River and Hoko River watersheds. Wydoski and Whitney (2003) include the Lake Ozette watershed within the range of prickly, reticulate, riffle, coastrange, and torrent sculpins. Additional complexities in the identification of species within the watershed also exist. Reticulate and riffle sculpins are not clearly separated by existing taxonomic descriptions (Wydoski and Whitney 2003), further hindering obtaining conclusive evidence of the existence of one or both of these species in the Ozette watershed. During sockeye fry trapping in Umbrella Creek in the spring of 1999, sculpins of undermined species (any of the 5 potentially present species) were observed preying upon juvenile sockeye and coho in the trap. Sockeye were preyed upon in much higher numbers than other species present in the trap, even though coho salmon fry outnumbered sockeye at a ratio of up to 10:1.

2.2.2.1 Prickly Sculpin (Cottus asper)

Mongillo and Hallock (1997) captured this sculpin species at two sampling locations along the shoreline of Lake Ozette but none in the tributaries to the lake. Dlugokenski et al. (1981) captured and examined the stomach contents of 74 prickly sculpins and found that 1/3 of the stomach contents were fish eggs. No fish species were present in any of the stomach contents examined, but this is could be a function of sample timing and location. Prickly sculpin are known to feed on small fishes, including redside shiner, threespine stickleback, longfin smelt, yellow perch, lamprey, and juvenile salmonids (Wydoski and Whitney 2003). Wydoski and Whitney (2003) suggest that prickly sculpin may eat more fish than other species of sculpin because they grow larger than other species of sculpin, allowing them to capture and swallow fish more easily. During the

fall of 1998 in Lake Washington, 53% of the diet of prickly sculpin > 150 mm TL were sockeye salmon pre-smolt (Warren personal communication 2000 *in* Wydoski and Whitney 2003). Beauchamp and LaRiviere (1993) concluded that prickly sculpin were an important prey food for both cutthroat trout and northern pikeminnows in Lake Ozette.

2.2.2.2 Reticulate and Riffle Sculpin (C. perplexus; gulosus)

As described above, information on the distribution and abundance of these sculpin species is not available for the Ozette watershed. Mongillo and Hallock (1997) captured reticulate sculpin at two sampling locations in Big River but not at any of the other sampling locations in the watershed. Reticulate and riffle sculpins are not clearly separated by existing taxonomic descriptions (Wydoski and Whitney 2003). However, a riffle sculpin was collected from Allen's Bay in 1991 and is part of the University of Washington fish collection. Riffle sculpin feed primarily on crustaceans, aquatic insect larvae, and snails (Wydoski and Whitney 2003). In the Cedar River, riffle/reticulate sculpins as small as 45mm TL consumed sockeye fry (Tabor and Chan 1996). Reticulate sculpin feed primarily on immature aquatic insects and larvae of other insects, such as midges, beetles, and caddisflies (Wydoski and Whitney 2003). Reticulate sculpin are also known to feed on other sculpin, salmon eggs, and fry (Wydoski and Whitney 2003). Reticulate sculpin can burrow into gravel and cobble substrates quite deeply; sculpin 50-75 mm can penetrate substrate to depths of 175mm (Wydoski and Whitney 2003).

2.2.2.3 Coastrange Sculpin (Cottus aleuticus)

Wydoski and Whitney (2003) describe the coastrange sculpin as inhabiting medium- to large-size rivers with moderate current and being distributed along the entire Olympic Peninsula. Coastrange sculpins in Olympic Peninsula streams have been documented to prefer habitats with current, which segregates them from habitat types used by coastrange and prickly sculpins (Wydoski and Whitney 2003). Coastrange sculpin feed primarily on stoneflies and other aquatic insects, but may also feed on salmon eggs and fry (Wydoski and Whitney 2003). Foote and Brown (1998) found that the largest sculpins could consume 50 fresh sockeye eggs per day (130/week). They found sculpin densities in sockeye nests as high as 100 sculpins per m^2 in Lake Iliamna, Alaska. Coastrange sculpin as small as 50mm TL have been found to feed on sockeye fry in the Cedar River, Washington (Wydoski and Whitney 2003).

2.2.2.4 Torrent Sculpin (Cottus rhotheus)

As described above, information on the distribution and abundance of torrent sculpin are not available for the Ozette watershed. Mongillo and Hallock (1997) did not capture this sculpin species at any of their sampling sites within the watershed. Lake Ozette is within the reported range of torrent sculpins by Wydoski and Whitney (2003). Torrent sculpin

feed primarily on similar prey items to prickly sculpin but frequent higher velocity habitats in streams (Wydoski and Whitney 2003).

2.2.3 Western Brook Lamprey (*Lampetra richardsoni*)

There is some confusion with respect to the presence of western brook lamprey in the Ozette watershed. Spawning lampreys of undetermined species approximately 6 inches (150 mm) long have been observed above falls and/or culverts that were thought to be anadromous barriers (Mike Haggerty, personal communication, 2004). Two spawning lampreys approximately 6 inches (150 mm) long were also observed in late June 2004 in Crooked Creek (Andy Ritchie, personal communication, 2004). It was assumed that these individuals were brook lamprey. However, MFM (2000) and NMFS (2003) both state that river lamprey (*Lampetra ayresi*) are present within the watershed. Mongillo and Hallock (1997) found no river lamprey at any of their sampling sites on the Olympic Peninsula. Only one documented occurrence of river lamprey on the Olympic Peninsula was found by Mongillo and Hallock (1997) and that occurred in Lake Cushman in 1931. Since brook lamprey are non-anadromous, and given the size of observed spawning lampreys, it is probable that western brook lamprey were the species found above what were believed to be anadromous barriers in the Ozette watershed. Mongillo and Hallock (1997) found no western brook lamprey at any of the sampling sites within the watershed and did not include this species as being potentially present even though it is found just a few miles away in the Quillayute River.

2.2.4 Pacific Lamprey (*Lampetra tridentata*)

Little is known about the abundance of Pacific lamprey within the Ozette watershed. They are relatively common in most of the larger streams, including Ozette River, Umbrella Creek, Big River, and Crooked Creek. They may be common in small streams as well, but very limited data are available. Meyer and Brenkman (2001) found at least three lamprey in Siwash Creek but did not identify the species. Lamprey have been observed transiting the sockeye weir between mid-April and July but only in very low numbers, likely because they are able to pass through the pickets and are not forced to transit through the weir opening where the camera is positioned. Several lamprey were captured during adult sockeye trapping in the spring and early summer of 2000. A total of 909 sockeye were captured but not handled. Only visual observation of these fish occurred, and it was determined that at least 3.9% of the sockeye either had attached lamprey or lamprey scars (both fresh and old).

Lamprey have also been captured during smolt trapping activities in the Ozette River. These have included both adults (spawning size) and small lamprey in adult form (presumed to be juveniles migrating to sea). Lamprey have been found in the stomach contents of large northern pikeminnows captured from the Ozette River. Between 2001 and 2004, an average of 5-10 lamprey have been captured during smolt trapping activities in the Ozette River. More quantitative data are available for Pacific lamprey abundance

in Umbrella Creek from sockeye fry trapping during the spring of 1999. A total of 82 lamprey were captured; 9 were adults and 73 were juveniles (adult form but small size < 20cm) apparently in the process of migrating to sea.

2.2.5 Threespine Stickleback (*Gasterosteus aculeatus*)

Threespine stickleback are thought to occur in low numbers in the Ozette watershed (Beauchamp and LaRiviere 1993). They have been captured in low numbers (6 and 7 individuals in 2003 and 2004, respectively) in the Ozette River smolt trap. Miscellaneous observations have also occurred in different areas of the lake. No threespine stickleback were captured during sockeye fry trapping in Umbrella Creek in 1999 and 2001. No threespine stickleback were captured by Meyer and Brenkman (2001) or Mongillo and Hallock (1997) in efforts to determine species composition at several sites in tributaries to Lake Ozette. They have been observed in Trout Creek, a tributary to Big River. Beauchamp and LaRiviere (1993) attempted to capture threespine stickleback in vertical gill nets and baited minnow traps in the lake but were unsuccessful. Typically, threespine stickleback make up a major component of coastal cutthroat trout diets; however, they were absent in the diet of cutthroat trout in examined in Lake Ozette (Beauchamp and LaRiviere 1993). These are important observations, because threespine stickleback can compete with sockeye and reduce the quantity and quality of food available for sockeye fry/parr consumption (Burgner 1991). This does not appear to be the case in Lake Ozette (Dlugokenski et al. 1981; Beauchamp et al. 1995). Ruggerone (1991) found that threespine stickleback aggregations can potentially create predation refuge for sockeye salmon fry from predatory juvenile coho salmon.

2.2.6 Olympic Mudminnow (*Novumbra hubbsi*)

Little is known about the abundance and distribution of Olympic mudminnows in the Ozette watershed. Jacobs et al. (1996) reported that the question of mudminnows being native to the Ozette watershed remained unresolved. However, Mongillo and Hallock (1999) concluded that Olympic mudminnows were indeed native to Ozette. They hypothesized that because Ozette remained ice free during the last glaciation, the basin provided refugia to Olympic mudminnows, as well as many other species. Olympic mudminnows have been documented in at least 6 sites in the Ozette watershed, including Ericson's Bay, Allen's Bay, Boot Bay, and Swan Bay. Mudminnows require three habitat characteristics, and if any one of these characteristics is missing, no mudminnows will be present: 1) several centimeters of soft mud bottom substrate, 2) little or no water flow, and 3) an abundance of aquatic vegetation (Mongillo and Hallock 1999). Statewide population trends are considered stable, but mudminnows are extremely sensitive to habitat alterations. Mudminnows are not considered competitors with sockeye, since there is little if any overlap in habitats utilized and food consumed.

2.2.7 Peamouth (*Mylocheilus caurinus*)

Peamouth are a species of chub that occur throughout the lake. Dlugokenski et al. (1981) noted that peamouth were the most abundant fish captured during their gillnetting study. They found fish in spawning condition in all of their sampling locations from mid-April to mid-June, with the highest concentrations occurring in May. Peamouth are known to spawn in the Ozette River and Umbrella Creek. Peak entry and spawning activity in Umbrella Creek occurs around Memorial Day, when black clouds of peamouth can be observed spawning just downstream of the Hoko-Ozette Road. They likely spawn in other tributaries to Lake Ozette, but no data are available regarding their use of other tributaries. Peamouth are captured in the Ozette River smolt trap in relatively high numbers; in 2001, 2003, and 2004 there were 928, 174, and 418 peamouth captured, respectively.

Within the lake it was concluded that peamouth have minimal spatial overlap with sockeye salmon because of the observed nearshore distribution of the species (Dlugokenski et al. 1981). Gillnet captures indicate that small peamouth occur in Lake Ozette offshore areas at depths of 1-40 meters (in low numbers) and that large individuals tend to occur in nearshore areas (Beauchamp and LaRiviere 1993; Jacobs et al. 1996). Peamouth diets are dominated by benthic prey items for all size classes of fish throughout the entire year (Beauchamp et al. 1993). Jacobs et al. (1996) reported that peamouth ate sockeye salmon eggs but that the extent of this behavior was unknown. Dlugokenski et al. (1981) concluded that peamouth were likely not significant competitors with sockeye salmon in Lake Ozette.

2.2.8 Northern Pikeminnow (*Ptychocheilus oregonensis*)

In the past, some have speculated that northern pikeminnows may have been introduced to Lake Ozette (e.g. Jacobs et al. 1996); however, Kemmerich (1926) describes homesteaders stating in 1923 that the lake is "*full of squaw fish [northern pikeminnow].*" These early observations should dispel any suggestion that northern pikeminnow were introduced to lake. They are present in the nearby Dickey Lake and Dickey River and were considered native in Lake Ozette in a recent review of non-game fishes conducted by Mongillo and Hallock (1997). Pikeminnows are quite abundant in Lake Ozette. Dlugokenski et al. (1981) state that northern pikeminnows were the second most abundant fish species captured in gillnet samples taken from Lake Ozette during randomized monthly sampling from 1977 to 1979. Beauchamp et al. (1995) speculated that the population of large (>300mm), northern pikeminnows numbered 5,000 to 15,000 based upon nearshore gillnet sampling. The distribution within the Ozette watershed appears limited to the lake and upper Ozette River. Large schools of northern pikeminnow congregate at the lake's outlet as early as mid-April and peak in late May through June. Most individuals are ripe and in spawning condition. While in the upper river these fish feed primarily on juvenile salmonids, mostly sockeye and coho smolts, but they have been observed eating other species present in the Ozette River, including yellow perch and redside shiners. During the spring of 2001, approximately 1,108

northern pikeminnows were captured in the smolt trap and in 2002, 2003, and 2004 an additional 366, 31, and 403 fish were captured, respectively.

The lake's outlet and upper-river area appears to be a major spawning site for northern pikeminnows from Lake Ozette. The area adjacent to Garden Island also is known to be a significant spawning site for northern pikeminnows in Lake Ozette. The diet of northern pikeminnows has been examined in detail. Dlugokenski et al. (1981) determined that terrestrial insects composed 37% of the year-round diet and benthic invertebrates 21%. The remaining diet was 21% fish, 14% aquatic insects, and 7% plant matter. However, the sampling design did not incorporate the off-shore component of the northern pikeminnow population. Beauchamp and LaRiviere (1993) sampled the off-shore environment and determined that only 2-29% of the northern pikeminnow population used the off-shore environment (depending upon the season). However, in the summer, 100% of the limnetic northern pikeminnow's diet was composed of sockeye/kokanee (Beauchamp and LaRiviere 1993). In the winter, up to 90% of their diet was composed of sockeye/kokanee (Beauchamp and LaRiviere 1993). All northern pikeminnows greater than 450 mm in length captured in the limnetic zone fed exclusively on sockeye/kokanee (Beauchamp and LaRiviere 1993). No studies have been conducted exclusively focusing upon potential impacts of northern pikeminnows feeding at the lake's outlet or in the Ozette River during the smolt emigration period.

2.2.9 Redside Shiner (*Richardsonius balteatus*)

The abundance, distribution, and life history of redside shiners in the Ozette watershed is poorly documented and understood. Redside shiners are present throughout the lake and the Ozette River. They have been captured in the Ozette River smolt trap in moderate numbers. A total of 51, 1, 18, and 8 redside shiners were captured in 2001, 2002, 2003, and 2004 respectively. No captures were indicated in studies conducted by Dlugokenski et al. (1981) or Beauchamp and LaRiviere (1993). Redside shiners did not appear in the diets of any of the piscivorous fish species in these studies, which is surprising since they compose a portion of coastal cutthroat diets in other Olympic Peninsula lakes (e.g. Lake Sutherland). The degree to which they compete and interact with sockeye in Ozette is not understood. Juvenile redside shiners feed on zooplankton and algae (Jacobs et al. 1996). Adults feed on insects and snails and zooplankton when in the pelagic zone (Jacobs et al. 1996) and may compete with sockeye for zooplankton in the pelagic zone (NMFS 2003).

2.3 EXOTIC FISH POPULATIONS

Exotic fish populations in the Lake Ozette watershed are tui chub, American shad, yellow perch, largemouth bass, and brown bullhead.

2.3.1 Tui Chub (*Gila bicolor*)

The presence of tui chub was not documented in Lake Ozette until the spring of 2002. Mongillo and Hallock (1997) do not include tui chub as a species native to the Olympic

Peninsula. Wydoski and Whitney (2003) do not include the Ozette watershed as part of the range of this species. Fish identified as tui chub have been captured in the Ozette River smolt trap. A total of 30, 1, and 3 tui chub were captured in the smolt trap in 2002, 2003, and 2004. Upon hatching, young tui chub feed on diatoms, rotifers, desmids, and other microscopic food (Wydoski and Whitney 2003). Juveniles feed on zooplankton, including copepods and cladocerans, while adults feed on plankton, insects, crustaceans, fish larvae, and fry (Wydoski and Whitney 2003). Wydoski and Whitney (2003) noted that tui chub often become overpopulated and compete with young trout. This does not appear to be the case in Lake Ozette. Further research is needed to understand the abundance and distribution of this species, as well as the species' origin and history in Ozette. It seems peculiar that it is present in Lake Ozette and not in any other nearby habitats.

2.3.2 American Shad (*Alosa sapidissma*)

American shad were first observed and captured in the Ozette watershed on June 16, 2000 during adult sockeye trapping operations. A single fish was collected and transferred to ONP for archiving in their fish collection. Little is known about shad abundance and distribution in the watershed. American shad have been observed entering the lake in relatively low numbers. A total of 6 adult shad were captured in the Ozette River during smolt trapping operations between 2000 and 2004. It is thought that the shad observed in Ozette are dip-ins and that they do not spawn in the lake or its tributaries. No juvenile shad have ever been captured in the lake or any of its tributaries. Much higher numbers of shad have been observed in the lower Ozette River. Groups of shad including 20-40 individuals were observed in the inter-tidal reaches and reaches just upstream from the zone of tidal influence during a snorkel survey conducted in the summer of 2000.

2.3.3 Yellow Perch (*Perca flavenscens*)

Yellow perch are not native to Lake Ozette. The earliest documentation of yellow perch introductions into the lake comes from a Port Angeles Evening News article (August 17, 1929). This article describes volunteers from the Izaak Walton League transporting yellow perch from Lake Pleasant to Lake Ozette in live boxes. Dlugokenski et al. (1981) concluded that yellow perch were the third most abundant fish species in Lake Ozette based upon gillnet captures in the nearshore environment. They found that yellow perch were in advanced stages of sexual maturity for eight months out of the year (February through May, and October to December). Beauchamp and LaRiviere (1993) found that low numbers of perch used the pelagic portions of the lake and that all pelagic perch were <200mm FL. In the pelagic zone, fish were captured at depths of only 2-3 m in April, but were much deeper (19-38 m) in autumn. Pelagic perch captured in the lake did not consume zooplankton; they fed primarily on insects and benthic invertebrates. However, the smallest perch (<125mm) were not susceptible to capture in the vertical gillnets used and therefore no prey analysis could be performed on these fish.

In other lakes, young perch feed on zooplankton, particularly cladocerans and copepods (Wydoski and Whitney 2003). In Lake Ozette, larger perch (>150 mm) were captured almost exclusively in the nearshore environment, where they fed primarily on insects, invertebrates, sculpin, and unidentified fish species (Beauchamp and LaRiviere 1993). The largest perch (>250 mm) became cannibalistic during winter and spring (Beauchamp and LaRiviere 1993). Yellow perch were not found to prey on sockeye salmon in Lake Ozette in studies conducted by Dlugokenski et al. (1981) or Beauchamp and LaRiviere (1993). Tabor and Chan (1996) found that yellow perch did not prey upon juvenile salmonids in Lake Washington. Little spatial overlap exists between piscivorous perch (>200 mm) and juvenile sockeye, making yellow perch an unlikely predator of juvenile sockeye. However, yellow perch compete for zooplankton resources in Lake Ozette. Dlugokenski et al. (1981) concluded that yellow perch <119mm FL fed primarily on zooplankters and thus were directly competing with juvenile sockeye salmon. Beauchamp and LaRiviere (1993) concluded that young yellow perch could represent a significant source of competition for the zooplankton resource in Lake Ozette during early spring.

2.3.4 Largemouth Bass (*Micropterus salmoides*)

Largemouth bass are not native to Lake Ozette. The history and timing of the introduction of this species is currently unknown. Little is known about the distribution and abundance of largemouth bass in Lake Ozette. Dlugokenski et al. (1981) report the presence of largemouth bass in the lake but do not include data on catch in the nearshore gillnets used for fish sampling. Beauchamp and LaRiviere (1993) caught only six largemouth bass during their vertical and nearshore gillnet sampling in the lake. They concluded that largemouth bass are not very vulnerable to gillnets. Other largemouth bass captures in the lake have typically occurred in shallow bays. In general, largemouth bass prefer clear water with bottoms composed of mud, sand, and organic material, which provide optimal substrates for rooted aquatic vegetation (Wydoski and Whitney 2003). Largemouth bass are seldom encountered at depths > 10 to 20 feet (Wydoski and Whitney 2003). The only identifiable fish remains in largemouth bass captured by Beauchamp and LaRiviere (1993) were yellow perch. Beauchamp and LaRiviere (1993) concluded that largemouth bass and juvenile sockeye were spatially segregated during the growing season but a combination of conditions in spring could draw the bass nearshore earlier while fry and smolts pass through the littoral zone, making juvenile sockeye susceptible to predation by largemouth bass. Largemouth bass fry in Lake Washington primarily feed on copepods, cladocerans, and midge larvae (Wydoski and Whitney 2003). In Lake Sammamish, largemouth bass feed extensively on fish, with 42% of their diet composed of salmonids (Wydoski and Whitney 2003).

2.3.5 Brown Bullhead (*Ictalurus nebulosus*)

Brown bullhead are not native to Lake Ozette. The history and timing of the introduction of this species is currently unknown. Little is known about the distribution and

abundance of brown bullhead in Lake Ozette. This species was first identified as present within the lake by ONP in the early 1990s. Additional captures of this species have occurred on two occasions during sockeye trapping operations in the Ozette River. Based upon the low number of encounters of this species, it is difficult to summarize its potential range and feeding patterns within the lake. However, it is unlikely that brown bullhead would have been susceptible to the gear types used in the food web investigations conducted by Dlugokenski et al. (1981) and Beauchamp and LaRiviere (1993). In tagging studies conducted in Lake Washington, brown bullhead were recaptured only near the location where they were tagged (Wydoski and Whitney 2003). In another tagging study conducted in Folsom Lake (CA), tagged brown bullhead moved an average of 1.7 miles prior to being recaptured, with a maximum movement of 16.2 miles (Wydoski and Whitney 2003). In general, young brown bullhead feed primarily on zooplankton (including cladocerans, such as *Daphnia*) and midge larvae, while larger fish feed on midges, mayflies, worms, and crustaceans (Wydoski and Whitney 2003). Stomach contents of brown bullhead captured in Lake Washington contained primarily fish eggs (94% by weight) and benthic invertebrates; no fish remains were observed (Tabor and Chan 1996). Tabor and Chan (1996) captured one brown bullhead in the Cedar River (Lake Washington, WA) and examined its stomach contents, which revealed it had consumed one coho smolt.